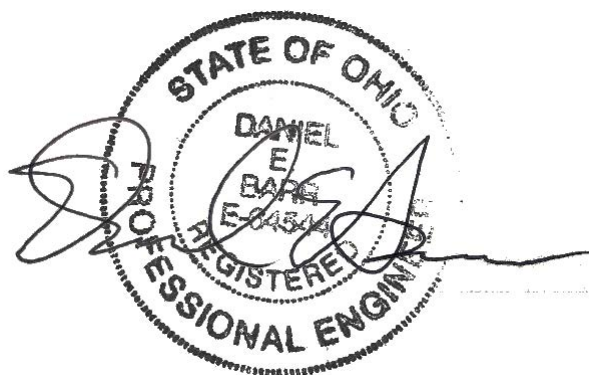


WWTP Improvements - Rebid
City of Sunbury
WPCLF and
Ohio Builds
Water & Wastewater Infrastructure
Program
Round 5 - ARPA Funded Project



21000706

CITY OF SUNBURY OFFICIALS

ADMINISTRATION

Joseph St. John, Mayor

Daryl Hennessy, Administrator

David Brehm, Esq., Director of Law

Dana Steffan, CPA, Director of Finance

Robert Howard, Police Chief

Wes Hall, P.E., City Engineer

COUNCIL

John Grumney, President

Damin Cappel, Member

Dave Martin, Member

Cindi Cooper, Member

Murray Neff, Member

Molly Drayer, Member

Amber Swain, Clerk of Council

ADVERTISEMENT FOR BIDS/PUBLIC NOTICE TO BIDDERS

Sealed bids will be received at the Sunbury Municipal Building, 9 East Granville Street, Sunbury, Ohio 43074 until 3:00 p.m. on December 6, 2024 and will be opened and read immediately thereafter for the

WWTP IMPROVEMENTS - Rebid

**WPCLF and
OHIO BUILDS Water & Wastewater Infrastructure Program
Round 5 - ARPA Funded Project**

OPINION OF PROBABLE CONSTRUCTION COST: \$24,500,000.00

COMPLETION DATE: 730 DAYS FROM NOTICE TO PROCEED

Bids mailed or otherwise submitted via the United States Postal Service (USPS) shall use the Sunbury mailing address: P.O. Box 508, 9 E. Granville Street, Sunbury, Ohio 43074. The USPS does not deliver to the building, only to the post office box.

The bid specifications, drawings, plan holders list, addenda, and other bid information (**but not the bid forms**) may be viewed and/or downloaded for free via the internet at <https://bids.ctconsultants.com>. The bidder shall be responsible to check for Addenda and obtain same from the web site.

Bids must be in accordance with drawings and specifications and on forms available from CT Consultants, Inc. at a non-refundable cost of Three-Hundred-and-Fifty Dollars (\$350.00) for hard copies and \$45.00 for electronic files. Documents may be ordered by registering and paying online at <https://bids.ctconsultants.com>. Please contact planroom@ctconsultants.com or call (440) 530-2395 if you encounter any problems viewing, registering, or paying for the documents.

There will be a Non-Mandatory Pre-Bid Conference on November 21, 2024 at 10:00 a.m. at the Sunbury Municipal Building, 9 East Granville Street, Sunbury, Ohio 43074.

This project will be funded by the Water Pollution Control Loan Fund Program as administered by the Ohio Environmental Protection Agency and the Ohio Water Development Authority. The Contractor shall note that there are Disadvantaged Business Enterprise participation goals for this project.

This procurement is subject to the EPA policy on encouraging the participation of small business in rural areas (SBRAs).

Publish: *Delaware Gazette*
November 13, 2024
November 20, 2024

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06/24

SECTION 1
BID DOCUMENTS

INSTRUCTIONS TO BIDDERS

PART 1 GENERAL

- 1.1 Sealed bids shall be received by the Owner at the location specified and until the time and date specified in the Advertisement for Bids/Public Notice to Bidders.
- 1.2 Each bid shall contain the full name and address of each person or company interested in said bid. If no other person be so interested, the Bidder shall distinctly so state the fact.
- 1.3 Bid forms must be completed in ink or by typewriter. Any corrections to the bid forms prior to submission must be initialed by the person signing the bid. Failure to submit any bid form(s) or other required document(s) may be cause for rejection of the bidder's bid at the sole discretion of the Owner.
- 1.4 Bids by Corporations must be executed in the corporate name by the President, Vice President, or other officer accompanied by evidence of authority to sign and the corporate seal must be affixed and attested by the Secretary on the Corporate Resolution form.
- 1.5 Bids by partnerships must be executed in the partnership name and signed by a partner, whose title must appear under the signature.
- 1.6 All names must be typed or printed below the signature.
- 1.7 The bid shall contain an acknowledgment of receipt of all Addenda.
- 1.8 If a Bidder wishes to withdraw their bid prior to the opening of bids, they shall state their purpose in writing to the Owner before the time fixed for the opening, and when reached it shall be handed to them unread.
- 1.9 After the opening of bids, no Bidder may withdraw their bid for a period of 150 days.

PART 2 EXAMINATION OF CONTRACT DOCUMENTS AND SITE

- 2.1 Before submitting a bid, each Bidder must
 - A. Examine the Contract Documents thoroughly.
 - B. Visit the site to familiarize themselves with local conditions that may in any manner affect cost, progress, or performance of the work.
 - C. Familiarize themselves with Federal, State, and local laws, ordinances, rules, and regulations that may in any manner affect cost, progress, or performance of the work.
 - D. Study and carefully correlate Bidder's observations with the Contract Documents.

- 2.2 Reference is made to the Specific Project Requirements for the identification of any reports of investigations and tests of subsurface and latent physical conditions at the site or otherwise affecting cost, progress or performance of the work which have been relied upon by the Engineer in preparing the drawings and specifications. Owner will make copies of such reports available to any Bidder requesting them if not made available with the bid documents. These reports are not guaranteed as to accuracy or completeness; nor are they part of the Contract Documents. Before submitting their bid each Bidder will, at their own expense, make such additional investigations and tests as the Bidder may deem necessary to determine their bid for performance of the work in accordance with the time, price and other terms and conditions of the Contract Documents.
- 2.3 Upon request, the Owner will provide each Bidder access to the site to conduct such reasonable investigations and tests as each Bidder deems necessary for submission for their bid.
- 2.4 The lands upon which the work is to be performed, rights-of-way for access thereto, and other lands designated for use by Bidder in performing the work are identified on the Drawings.
- 2.5 The submission of a bid will constitute an incontrovertible representation by the Bidder that they have complied with every requirement of this section and that the Contract Documents are sufficient in scope and detail to indicate and convey understanding of all terms and conditions for performance of the work.

PART 3 ESTIMATED QUANTITIES

- 3.1 In Unit Price Contracts, the quantities of the work itemized in the bid are approximate only and the bidders are hereby notified that the estimated quantities made by the Engineer are merely for the guidance of the Owner in comparing on a uniform basis all bids received for the work.
- 3.2 The contract quantities, where itemized, are based on plan horizontal and vertical dimensions unless otherwise specified. It is the Contractor's responsibility to verify and determine actual quantities of materials such as pipe, pavement, subgrade, etc. in their ordering materials.
- 3.3 Payments, except for lump sum contracts and except for lump sum items in unit price contracts, will be made to the Contractor only for the actual quantities of work performed or materials furnished in accordance with the plans and specifications.
- 3.4 The successful Bidder will be required to furnish the Owner with a complete breakdown of the lump sum bid items, to the satisfaction of the Engineer/Architect, before signing the Contract documents.

PART 4 CONTRACTOR'S QUALIFICATION

- 4.1 Bidder shall provide detailed information relating to similar projects completed within the past 5 years which demonstrates the bidder's capability, responsibility, experience, skill, and financial standing to undertake this type of project and shall include a list of all projects currently under construction including status and contact person.
- 4.2 Bidder shall own, have rental or lease agreements for, or otherwise have readily available any and all equipment and tools necessary for proper execution of the work. The Owner reserves the right to request lists of equipment or tools available for the project including sources.
- 4.3 Bidder shall provide pertinent information to the Owner relative to any pending suits or outstanding liens. If no information is provided by the Bidder, the Owner shall assume that any such suits or liens do not exist.
- 4.4 The Owner may require similar information on any or all subcontractors proposed by the Bidder.
- 4.5 Bids of corporations not chartered in the state in which the work will take place must be accompanied by proper certification that the corporation is authorized to do business in that state.

PART 5 SUBCONTRACTORS

- 5.1 The Bidder shall state on the appropriate bid form the names of all Subcontractors, Sub Consultants and other professional service providers proposed and the items of work they are to be assigned. All work not assigned to a Subcontractor shall be assumed by the Owner to be performed by the Bidder.
- 5.2 The Owner reserves the right to approve all subcontractors proposed by the Bidder. If the Owner, after due investigation, rejects the use of a proposed subcontractor, the apparent successful Bidder may either submit an acceptable substitution without increase in bid price or decline substitution and withdraw their bid without sacrificing their bid security. Any listed subcontractor to whom the Owner does not make written objection prior to award of contract, shall be deemed acceptable to the Owner.
- 5.3 Requests for changes of Subcontractor by the Bidder after the award shall be subject to the Owner's approval and shall not change the contract bid prices.
- 5.4 No contractor shall be required to employ any Subcontractor, person or organization against whom they have reasonable objection.

PART 6 BID REVIEW BY OWNER

- 6.1 The Owner reserves the right to reject any and all bids, to waive as an informality any and all irregularities, and to disregard all nonconforming, nonresponsive or conditional bids.

- 6.2 All extensions and totals of unit prices and quantities submitted as part of the bid shall be considered informal until verified by the Owner. All bids must be made on the forms contained herein and the bid prices must be written therein, in figures only. Unit prices shall be separately written for "Unit Price Labor," "Unit Price Material," and "Total Unit Price" for each item listed. Should an error in addition and/or multiplication be determined while checking the Contractor's math and verifying their total bid, the "Unit Price Labor" and the "Unit Price Material" figures shall govern in determining the correct "Total Unit Price" and the correct "Item Total."
- 6.3 Each bidder must bid on all Items, Alternates, Deductions, and Additions contained in the Bidding Forms. All bids not in conformity with this notice may be considered non-responsive and may be rejected.
- 6.4 More than one bid for the same work from an individual or entity under the same of different names will not be considered. Reasonable grounds for believing that any bidder has an interest in more than one bid for the work may be cause for disqualification of that bidder and the rejection of all bids in which the bidder has an interest. A subcontractor or supplier is not a bidder, and may submit prices to multiple bidders.
- 6.5 In evaluating bids, the Owner may consider:
- A. The qualifications and experience of the Bidder, proposed subcontractors, and principal material suppliers as outlined in the plans and specifications.
 - B. Financial ability and soundness of the Bidder and proposed subcontractors.
 - C. Completeness of all bid forms and bid requirements.
 - D. Alternates and unit prices requested in the Bid Forms.
 - E. Unit prices or schedules of values that are or appear to be unbalanced.
 - F. Previous contractual experience with the Owner.
 - G. Whether or not the bid package complies with the prescribed requirements.
 - H. The proposed completion date, if applicable.
 - I. Any other matter allowed by law or local ordinance or resolution.
- 6.6 Owner may conduct further investigations as they deem necessary to assist in the evaluation of any bid and to establish the responsibility, qualifications, and financial ability of the Bidder, proposed Subcontractors, and other persons and organizations to do the work in accordance with the Contract Documents to Owner's satisfaction within the prescribed time.
- 6.7 Owner reserves the right to reject the bid of any Bidder who does not pass any such evaluation to Owner's satisfaction.

- 6.8 The Contract award shall be based on the lowest and best bid or lowest responsive and responsible bid (as applicable for the public contracting agency receiving bids) for the base bid and selected alternate items (if any) for this project.

PART 7 BID SECURITY

- 7.1 Each bid must be accompanied by a certified or cashier's check in the amount of 10% of the amount bid, an irrevocable letter of credit in the amount of 10% of the amount bid or an original bond in the amount of 100% of the amount bid per ORC 153.54 and 153.571. The certified or cashier's check, or irrevocable letter of credit shall be from a financial institution authorized to transact business in the State of Ohio and acceptable to the Owner. The bond shall be underwritten by a Surety Company authorized to transact business in the State of Ohio having an Ohio agent and listed on the most current Department of the Treasury Circular 570, "Surety Companies Acceptable on Federal Bonds." The bond shall be a "Bid Guarantee and Contract Bond" ("rollover bond") per O.R.C. sections 153.54 and 153.571 submitted for the full amount of the bid **including all alternates**, if any.

If bid security is made by bond, the Bidder and their Surety shall sign the Supplemental Bond Acknowledgement form and submit with their bid.

- 7.2 The certified or cashier's check, irrevocable letter of credit, or bond shall be made payable to the Owner and shall serve as a guarantee that in the event the bid is accepted and a contract is awarded to the successful Bidder, the contract will be executed by the bidder including any certifications, certificates or additional bonds required by the contract.
- 7.3 Failure on the part of the successful Bidder to execute the contract documents will cause the certified or cashier's check, irrevocable letter of credit, or bond to be forfeited to the Owner as damages.
- A. If the Owner awards the contract without rebidding, the Bidder (and the Surety on their bond if a bond was submitted) shall be liable to the Owner for a penal sum not to exceed the difference between the low bid and the next lowest bidder or 10% of the amount of the bid, whichever is less.
- B. If the Owner does not award the Contract to the next lowest Bidder, but resubmits the project for bidding; the Bidder (and the Surety on their bond if a bond was submitted) shall be liable to the Owner for a penal sum not to exceed the costs in connection with the resubmission of bids or 10% of the amount of the bid, whichever is less.
- 7.4 Checks or letters of credit for bid security of all bidders will be returned in the manner and timeframe stipulated in the Ohio Revised Code.

PART 8 CONTRACT BOND

- 8.1 As security for faithful performance and payment of all obligations under the Contract, the Owner shall require and the successful Bidder shall furnish either:
- A. *If submitted as Bid Security at time of bid:* "Bid Guarantee and Contract Bond" (AKA "rollover bond") per O.R.C. sections 153.54 and 153.571.
 - B. *If a cashier's check or irrevocable letter of credit is submitted as Bid Security at time of bid:* Contract Bond per Ohio Revised Code Sections 153.54 and 153.57, in the amount of 100% of the Contract Price. The Contractor and their Surety shall sign the Supplemental Bond Acknowledgement form and submit with the Contract forms
- 8.2 The bond shall be underwritten by a Surety Company authorized to transact business in the State of Ohio having an Ohio agent and listed on the most current Department of the Treasury Circular 570, "Surety Companies Acceptable on Federal Bonds."
- 8.3 The contract bond shall cover correction of the work for the period stated in the specifications and the correction period shall start upon Final Acceptance of the entire project and final payment by the Owner.
- 8.4 Nothing in the performance of the Engineer's service to the Owner in connection with this project shall in any way imply any undertaking for the benefit of the successful Bidder, its subcontractor(s), or the surety of any of them.

PART 9 AWARD AND EXECUTION OF CONTRACT

- 9.1 After the Owner's legislative body awards the project, the successful bidder will receive the unsigned contract documents. Within 10 days after their receipt, the successful Bidder shall sign and deliver to the Owner said contract documents including any certifications, certificates, or additional bonds required by the contract.
- 9.2 The Owner shall execute the Contract within 150 days after the day of the bid opening. When necessary and by mutual consent between the Owner and the Successful Bidder, this 150-day period may be extended.
- 9.3 The date of the Owner's signature on the Contract Agreement shall be the effective contract date.
- 9.4 The Owner shall execute and deliver to the successful Bidder one set of fully executed contract documents.

PART 10 INSURANCE

- 10.1 Verification of limits for public liability, property damage, automobile, Worker's Compensation, or any other insurance required by the provisions of this Contract must be submitted to the Owner prior to execution of the Contract.

- 10.2 All insurance shall be endorsed so that it cannot be cancelled for non-payment of premium for 10 days or cancelled or non-renewed for any other reason in less than 30 days after a written notice of such proposed action by the insurer is given to the Owner. The cancellation clause on the Certificate(s) of Insurance shall read as specified in the Supplementary Conditions and failure to submit an insurance certificate and/or policy endorsement verifying same shall be reason for the Owner to consider the Contractor non-responsive in complying with the requirements for contract execution and may be cause for forfeiture of the Bid Security to Owner.
- 10.3 The Insurer's affording coverage shall be authorized to transact business in the State of Ohio and be listed on the most current Ohio Department of Insurance list of Ohio Licensed Companies.
- 10.4 The Contractor's Liability Insurance policy(s) shall be endorsed such that limits are on a Per Project basis.
- 10.5 The Contractor shall also provide an Owner's and Contractor's Protective Policy.

PART 11 NON-COLLUSION AFFIDAVIT

- 11.1 Collusion between bidders will be cause for rejection of affected bids and may be cause for rejection of all bids. Multiple bids submitted by one bidder under the same name or different names, whether as an individual, firm, partnership, corporation, profit or non-profit, affiliate, or association will be cause for rejection of bids. A subcontractor is not a bidder, and may submit prices to multiple bidders.
- 11.2 All bidders shall submit an affidavit that their bid is genuine and not collusive or sham; that such bidder has not colluded, conspired, connived, or agreed, directly or indirectly, with any bidder or person, to put in a sham bid, or that such other bidder or person shall refrain from bidding; that such bidder has not in any manner, directly or indirectly sought by agreement or collusion, or communication or conference, with any person, to fix the bid price of affiant or any other bidder, or to fix any overhead, profit or cost element of said bid price, or of that of any other bidder, or to secure any advantage against the Owner or any person or persons interested in the proposed contract; that such bidder is the only party (or parties) who has an interest with the bidder in the profits of any contract which may result from the herein contained proposal; that no individual affiliated with the Owner, including but not limited to the head of any department, any employee, or any other official or officer of the Owner, is or will be directly or indirectly interested in this bid, and/or the profits from this bid if successful; that no individual affiliated with the Owner, including but not limited to the head of any department, any employee, or any other official or officer of the Owner, has or will receive anything of value as a result of the submission of this bid or its award; that no individual affiliated with the Owner, including but not limited to the head of any department, any employee, or any other official or officer of the Owner, has been solicited to provide assistance and/or provided assistance to the bidder which might give the bidder a competitive advantage or circumvent the competitive bidding process; and that all statements contained in said proposal are true; and further, that such bidder has not, directly or indirectly submitted this bid, or the contents thereof, or divulged information or data relative thereto to any association or to any member or

agent thereof.

- 11.3 Each bid must be accompanied by a completed Noncollusion Affidavit provided within the contract documents.
- 11.4 Where there is reason to believe collusion or combination among bidders exists, the Owner reserves the right to reject the bid of those concerned.

PART 12 DELINQUENT PERSONAL PROPERTY STATEMENT

- 12.1 Included with the contract documents is a Delinquent Personal Property Statement to be filled out by the successful Bidder.
- 12.2 The statement shall be sent to both the County Auditor and the County Treasurer. A signed copy shall remain in the contract documents as well.

PART 13 ORIGINAL DOCUMENTS

- 13.1 All bid forms, contract forms, bonds and any other bid documents or contract documents requiring signatures shall be submitted with original signatures. No photo copies or faxed copies of signed documents shall be accepted.

PART 14 ADDENDA

- 14.1 The bidder shall be responsible to obtain Addenda from the web at <https://bids.ctconsultants.com>.

END OF SECTION 10/31/23

BID FORMS

The bid forms are not available online. The bid forms are available only by purchasing a set of plans and specifications at the location indicated in the Advertisement for Bids/Public Notice to Bidders.

SECTION 2
CONTRACT FORMS

NOTICE OF AWARD

TO: «ContractName»
«ContractAddr»
«ContractCity», «ContractState» «ContractZip»

PROJECT: «TitleCaps»

You are notified that your Bid which was opened on «Bidopening» has been accepted for items in the amount of «ContractDollars» at the unit bid prices as reflected in the bid tabulation contained herein for the *(fill in awarded parts, i.e. for Base Bid and Alternate C, or delete)*.

You are required by the Instructions to Bidders to execute the Agreement and furnish the required Bonds, Certificates of Insurance, and other documents within 10 calendar days from the date of receipt of this Notice.

Failure to comply with these conditions within the time specified will entitle Owner to consider your Bid in default, to annul this Notice and to declare your Bid Security forfeited.

The Owner will return to you one (1) fully signed set of the contract documents.

«OwnerCaps»

«OwnerCEOFirst» «OwnerCEOLast», «OwnerCEOTitle»

Date

ACKNOWLEDGMENT

«ContractCAPName»

DO NOT SIGN THIS PAGE. FOR REFERENCE ONLY. OWNER WILL SEND SIGNED COPY.

«ContractFirst» «ContractLast», «ContractTitle»

Date

CONTRACT

FOR «TitleCaps»

THIS CONTRACT, made and entered into at «OwnerCity», «OwnerState», this _____ day of _____, 20____, by and between the «OwnerMuni» (“OWNER”), «OwnerState» and «ContractName» (“CONTRACTOR”).

WITNESSETH: That the said CONTRACTOR has agreed and by this presents does agree with the OWNER for the consideration hereinafter mentioned and contained, and under penalty expressed in a bond given with these presents, and herein contained or hereunto annexed, to furnish at its own cost and expense, all the necessary tools, equipment, materials, labor, and tests in an expeditious, substantial and workmanlike manner, the equipment and appurtenances herein contemplated, commencing work within 20 days from the date of the Notice to Proceed and executing the work within the time and in the manner specified and in conformity with the requirements set forth in this Contract.

The following form essential parts of the Contract (may vary with project).

1. Advertisement for Bids/Public Notice to Bidders
2. Instruction to Bidders
3. Bid Forms and Proposal
4. Contract Forms and Exhibits
5. Contract Bond – ORC 153.571 or ORC 153.57
6. Contract Provisions
7. General Conditions
8. Supplementary Conditions
9. Specifications
10. Specific Project Requirements
11. Prevailing Wage Rate Schedule
12. Contract Drawings; if any.
13. Addenda; if any.

The CONTRACTOR agrees and understands that the work on this contract shall be subject to the acceptance of the OWNER based upon and in accordance with the contract specifications and contract plans and drawings on file in the office of the OWNER.

The CONTRACTOR agrees that each individual employed by the CONTRACTOR or any Subcontractor and engaged in work on the project under this contract shall be paid by prevailing wage established by the Department of Industrial Relations of the State of Ohio or the U.S. Department of Labor (Davis-Bacon Act) as detailed in the section titled "Wage Rates." This shall occur regardless of any contractual relationship which may be said to exist between the Contractor or any Subcontractor and such individual. *(if a School District, delete this paragraph)*

The CONTRACTOR shall proceed with the said work in a prompt and diligent manner and shall do the several parts thereof. Further the CONTRACTOR shall complete the whole of said work in accordance with the specifications and contract drawings to the satisfaction of the OWNER on or before the time stated, and in default of completion within the time as fixed, the CONTRACTOR shall pay to the OWNER as liquidated damages, an amount equal to «Liquidated», for each and every day (Sundays and legal holidays excepted) the completion of the work may be delayed beyond the date fixed in the manner and as stipulated.

It is hereby mutually agreed that the OWNER is to pay and the CONTRACTOR is to receive, as full compensation for furnishing all materials and labor in building, constructing and testing and in all respect completing the herein described work and appurtenances in the manner and under the conditions herein specified, the prices stipulated in the proposal herein contained or hereto annexed and the total contract sum is «ContractDollars».

This Contract shall be in full force and effect from the date of execution by the OWNER and CONTRACTOR.

IN WITNESS WHEREOF: The OWNER and CONTRACTOR hereunto affixed their signature the day and year first mentioned above.

«ContractCAPName»

«ContractFirst» «ContractLast», «ContractTitle»

«OwnerCaps»

«OwnerCEOFirst» «OwnerCEOLast», «OwnerCEOTitle»

I hereby certify that funds in the amount of «ContractAmtwords» Dollars («ContractDollars») necessary for the foregoing Contract have been appropriated and are in the Treasury, or are in the process of collection, or are available through grants and/or loans from other funding sources.

«OwnerFiscalFirst» «OwnerFiscalLast», «OwnerFiscalTitle»

APPROVED AS TO FORM:

«OwnerLegalName», «OwnerLegalTitle»

**THE CONTRACTOR SHALL FURNISH THE FOLLOWING ITEMS
WITHIN 10 DAYS OF NOTIFICATION OF AWARD:**

- A) **CERTIFICATE OF INSURANCE FOR
CONTRACTOR'S PUBLIC LIABILITY INSURANCE POLICY
AND AUTOMOTIVE INSURANCE POLICY**
Owner, CT Consultants, Inc. and Verdantas LLC Named as Additional Insured
- B) **CERTIFICATE OF INSURANCE FOR
OWNER'S AND CONTRACTOR'S PROTECTIVE POLICY**
Owner Named as Insured (No Additional Insured)
- C) **CERTIFICATE OF WORKER'S COMPENSATION**
- D) **CONTRACT BOND THAT COMPLIES WITH ORC 153.54 AND 153.57**

* D above is not required if a bond complying with ORC 153.54 and 153.571 (rollover bond) was submitted at time of bid.

DELINQUENT PERSONAL PROPERTY STATEMENT

STATE OF _____)
) SS
COUNTY OF _____)

«ContractName», having been awarded a contract by the «OwnerMuni», «OwnerState», hereby affirms under oath, pursuant to Ohio Revised Code Section 5719.042, that at the time the bid was submitted, my company **was / was not (CIRCLE ONE)** charged with delinquent personal property taxes on the General Tax List of Personal Property for «OwnerCounty» County, Ohio.

If such charge for delinquent personal property tax exists on the General Tax List of Personal Property for «OwnerCounty» County, Ohio, the amount of such due and unpaid delinquent taxes, including due and unpaid penalties and interest shall be set forth below.

A copy of this statement shall be transmitted by the Taxing District's Fiscal Officer to the County Treasurer within thirty days of the date it is submitted. A copy of this statement shall also be incorporated into the Contract made between «OwnerMuni», «OwnerState», and «ContractName», and no payment shall be made with respect to any Contract unless such statement has been so incorporated as a part thereof.

Delinquent Personal Property Tax	\$ _____
Penalties	\$ _____
Interest	\$ _____

«ContractCAPName»

«ContractFirst» «ContractLast», «ContractTitle»

Subscribed and sworn to before me this _____ day of _____, 20_____.

Notary Public

My Commission Expires: _____

ESCROW AGREEMENT FOR CONTRACTOR'S RETAINAGE

In accordance with a certain Contract between the «OwnerMuni», «OwnerState», (hereinafter referred to as "the Owner") and «ContractName», (hereinafter referred to as "the Contractor"), an Escrow Agent is hereby appointed to hold funds arising out of the Owner's agreement to pay retainage into an escrow fund, said Agent to be:

All retained funds will be placed with the above Escrow Agent from the date your Contract is certified as being 50% complete pursuant to Sections 153.13, and 153.14 and 153.63 Ohio Revised Code.

During the time the aforementioned retained funds are in the custody of the Escrow Agent, the Escrow Agent has authority to invest the escrow funds in the classes of securities listed below which, in the judgment of the Escrow Agent, allow for the least risk to capital preservation and provide for a reasonable income. The income from investment of the escrowed funds shall be accumulated in the escrow account.

- (a) Obligation issued or guaranteed as to interest and principal by the government of the United States, or obligations of the State of Ohio or any political subdivision thereof;
- (b) Obligations including certificates of deposit of any national bank located in this State and/or any bank as defined by Section 1101.01, O.R.C.;
- (c) Repurchase agreements fully secured by obligations of any kind specified in clauses (a) and (b) above; or
- (d) Interest in any money market fund or trust, the investments of which are generally restricted to obligations of any of the kind specified in clauses (a) through (c) above.

The Escrow Agent shall hold the escrowed principal and interest until receipt of notice from the Owner, or until receipt of an Arbitration Order or an Order of the Court of Claims, or other appropriate courts, specifying the amount of the escrowed principal to be released and the person to whom it is to be released. Upon receipt of such a request or order, the Escrow Agent shall, within 30 days, pay such amount of principal and interest earned on the retainage to the Contractor less the Escrow Agent's fee.

It is understood that the Escrow Agent shall have no duties, obligations, or liabilities hereunder other than to hold and invest said funds and to deliver them in accordance with the provisions hereof.

«ContractCAPName»

«ContractFirst» «ContractLast», «ContractTitle»

«OwnerCaps»

«OwnerFiscalFirst» «OwnerFiscalLast», «OwnerFiscalTitle»

ESCROW WAIVER

In accordance with a certain Contract between the «OwnerMuni», «OwnerState», (hereinafter referred to as "the Owner") and «ContractName», (hereinafter referred to as "the Contractor") it is mutually agreed by and between the parties hereto that because of the short-term duration of the within contract, no escrow account will be established pursuant to Sections 153.13, 153.14 and 153.63 of the Ohio Revised Code nor shall any interest be paid on any retainage.

«ContractCAPName»

«ContractFirst» «ContractLast», «ContractTitle»

«OwnerCaps»

«OwnerFiscalFirst» «OwnerFiscalLast», «OwnerFiscalTitle»

NOTICE TO PROCEED

Project: «Title»

Owner: «OwnerMuni»
«OwnerAddr»
«OwnerCity», «OwnerState» «OwnerZip»

To: «ContractName»
«ContractAddr»
«ContractCity», «ContractState» «ContractZip»

Date: _____

You are hereby notified to commence work in accordance with the Contract. All work shall be completed by «Completion_Date».

«OwnerCaps»

«OwnerCEOFirst» «OwnerCEOLast», «OwnerCEOTitle»

**Disadvantaged Business Enterprise (DBE) Program
DBE Subcontractor Performance Form**

This form is intended to capture the DBE¹ subcontractor's² description of work to be performed and the price of the work submitted to the prime contractor. An EPA Financial Assistance Agreement Recipient must require its prime contractor to have its DBE subcontractors complete this form and include all completed forms in the prime contractors bid or proposal package.

Subcontractor Name		Project Name	
Bid/ Proposal No.	Assistance Agreement ID No. (if known)	Point of Contact	
Address			
Telephone No.		Email Address	
Prime Contractor Name		Issuing/Funding Entity:	

Contract Item Number	Description of Work Submitted to the Prime Contractor Involving Construction, Services, Equipment or Supplies	Price of Work Submitted to the Prime Contractor
DBE Certified By: <input type="radio"/> ODOT <input type="radio"/> DAS/EDGE <input type="radio"/> Other: _____		Meets/ exceeds EPA certification standards? <input type="radio"/> YES <input type="radio"/> NO <input type="radio"/> Unknown

Check Which One Applies: _____ MBE _____ WBE (Include MBE/WBE Certificates, No DBE Certs)

¹ A DBE is a Disadvantaged, Minority, or Woman Business Enterprise that has been certified by an entity from which EPA accepts certifications as described in 40 CFR 33.204-33.205 or certified by EPA. EPA accepts certifications from entities that meet or exceed EPA certification standards as described in 40 CFR 33.202.

² Subcontractor is defined as a company, firm, joint venture, or individual who enters into an agreement with a contractor to provide services pursuant to an EPA award of financial assistance.

FORM 6100-3 (DBE Subcontractor Performance Form)

**Disadvantaged Business Enterprise (DBE) Program
DBE Subcontractor Performance Form**

I certify under penalty of perjury that the forgoing statements are true and correct. Signing this form does not signify a commitment to utilize the subcontractors above. I am aware of that in the event of a replacement of a subcontractor, I will adhere to the replacement requirements set forth in 40 CFR Part 33 Section 33.302 I.

Prime Contractor Signature	Print Name
Title	Date

Subcontractor Signature	Print Name
Title	Date

**Disadvantaged Business Enterprise (DBE) Program
DBE Subcontractor Utilization Form**

This form is intended to capture the prime contractor's actual and/or anticipated use of identified certified DBE¹ subcontractors² and the estimated dollar amount of each subcontract. An EPA Financial Assistance Agreement Recipient must require its prime contractors to complete this form and include it in the bid or proposal package. Prime contractors should also maintain a copy of this form on file.

Prime Contractor Name		Project Name	
Bid/ Proposal No.	Assistance Agreement ID No. (if known)	Point of Contact	
Address			
Telephone No.		Email Address	
Issuing/Funding Entity:			

I have identified potential DBE certified subcontractors	___YES	___NO	
If yes, please complete the table below. If no, please explain:			
Subcontractor Name/ Company Name	Company Address/ Phone/ Email	Est. Dollar Amt.	Currently DBE Certified?
	Continue on back if needed		

¹ A DBE is a Disadvantaged, Minority, or Woman Business Enterprise that has been certified by an entity from which EPA accepts certifications as described in 40 CFR 33.204-33.205 or certified by EPA. EPA accepts certifications from entities that meet or exceed EPA certification standards as described in 40 CFR 33.202.

² Subcontractor is defined as a company, firm, joint venture, or individual who enters into an agreement with a contractor to provide services pursuant to an EPA award of financial assistance.

**Disadvantaged Business Enterprise (DBE) Program
DBE Subcontractor Utilization Form**

I certify under penalty of perjury that the forgoing statements are true and correct. Signing this form does not signify a commitment to utilize the subcontractors above. I am aware of that in the event of a replacement of a subcontractor, I will adhere to the replacement requirements set forth in 40 CFR Part 33 Section 33.302 I.

Prime Contractor Signature	Print Name
Title	Date

AMERICAN IRON AND STEEL ACKNOWLEDGEMENT

The Contractor acknowledges to and for the benefit of the City of _____ (“Purchaser”) and the State of Ohio (the “State”) that it understands the goods and services under this Agreement are being funded with monies made available by the Clean Water State Revolving Fund and/or Drinking Water State Revolving Fund that have statutory requirements commonly known as “American Iron and Steel;” that requires all of the iron and steel products used in the project to be produced in the United States (“American Iron and Steel Requirement”) including iron and steel products provided by the Contractor pursuant to this Agreement. The Contractor hereby represents and warrants to and for the benefit of the Purchaser and the State that (a) the Contractor has reviewed and understands the American Iron and Steel Requirement, (b) all of the iron and steel products used in the project will be and/or have been produced in the United States in a manner that complies with the American Iron and Steel Requirement, unless a waiver of the requirement is approved, and (c) the Contractor will provide any further verified information, certification or assurance of compliance with this paragraph, or information necessary to support a waiver of the American Iron and Steel Requirement, as may be requested by the Purchaser or the State. Notwithstanding any other provision of this Agreement, any failure to comply with this paragraph by the Contractor shall permit the Purchaser or State to recover as damages against the Contractor any loss, expense, or cost (including without limitation attorney’s fees) incurred by the Purchaser or State resulting from any such failure (including without limitation any impairment or loss of funding, whether in whole or in part, from the State or any damages owed to the State by the Purchaser). While the Contractor has no direct contractual privity with the State, as a lender to the Purchaser for the funding of its project, the Purchaser and the Contractor agree that the State is a third-party beneficiary and neither this paragraph (nor any other provision of this Agreement necessary to give this paragraph force or effect) shall be amended or waived without the prior written consent of the State.

Signature

Date

Name and Title of Authorized Signatory, Please Print or Type

Bidder’s Firm

Check here if the WPCLF or WSRLA applicant will be requesting an individual waiver for non-American made iron and steel products. Please note that the waiver box does not need to be marked for nationwide waivers.

THE OWNER OR THEIR AUTHORIZED REPRESENTATIVE SHALL INSERT THE FOLLOWING CONTRACT DOCUMENTATION IN THE EXECUTED CONTRACT:

A) FINDINGS FOR RECOVERY – ORC 9.24
(<http://ffr.ohioauditor.gov/>)

B1) CHECK FOR DEBARRED CONTRACTORS IN THE STATE OF OHIO
(<https://www.sos.state.oh.us/records/debarred-contractors/>)

**B2) CHECK FEDERAL SAM (System for Award Management) for
FEDERAL FUNDING (including sub-contractors), (if applicable)**
(<https://www.sam.gov/SAM/>)

**C) NOTIFICATION OF SURETY AND AGENT OF CONSTRUCTION
CONTRACT AWARD – ORC 9.32 (if applicable)**

**D) NOTIFICATION TO UTILITY COMPANIES OF COMMENCEMENT
OF CONTRACT EXECUTION – ORC 153.64 (if applicable)**

SECTION 3
GENERAL CONDITIONS

This document has important legal consequences; consultation with an attorney is encouraged with respect to its use or modification. This document should be adapted to the particular circumstances of the contemplated Project and the controlling Laws and Regulations.

STANDARD GENERAL CONDITIONS OF THE CONSTRUCTION CONTRACT

Prepared by

ENGINEERS JOINT CONTRACT DOCUMENTS COMMITTEE

and

Issued and Published Jointly by



AMERICAN COUNCIL OF ENGINEERING COMPANIES

ASSOCIATED GENERAL CONTRACTORS OF AMERICA

AMERICAN SOCIETY OF CIVIL ENGINEERS

PROFESSIONAL ENGINEERS IN PRIVATE PRACTICE
A Practice Division of the
NATIONAL SOCIETY OF PROFESSIONAL ENGINEERS

Endorsed by



CONSTRUCTION SPECIFICATIONS INSTITUTE

These General Conditions have been prepared for use with the Suggested Forms of Agreement Between Owner and Contractor (EJCDC C-520 or C-525, 2007 Editions). Their provisions are interrelated and a change in one may necessitate a change in the other. Comments concerning their usage are contained in the Narrative Guide to the EJCDC Construction Documents (EJCDC C-001, 2007 Edition). For guidance in the preparation of Supplementary Conditions, see Guide to the Preparation of Supplementary Conditions (EJCDC C-800, 2007 Edition).

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1420 King Street, Alexandria, VA 22314-2794
(703) 684-2882
www.nspe.org

American Council of Engineering Companies
1015 15th Street N.W., Washington, DC 20005
(202) 347-7474
www.acec.org

American Society of Civil Engineers
1801 Alexander Bell Drive, Reston, VA 20191-4400
(800) 548-2723
www.asce.org

Associated General Contractors of America
2300 Wilson Boulevard, Suite 400, Arlington, VA 22201-3308
(703) 548-3118
www.agc.org

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STANDARD GENERAL CONDITIONS OF THE CONSTRUCTION CONTRACT

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ARTICLE 1 – DEFINITIONS AND TERMINOLOGY

1.01 *Defined Terms*

- A. Wherever used in the Bidding Requirements or Contract Documents and printed with initial capital letters, the terms listed below will have the meanings indicated which are applicable to both the singular and plural thereof. In addition to terms specifically defined, terms with initial capital letters in the Contract Documents include references to identified articles and paragraphs, and the titles of other documents or forms.
1. *Addenda*—Written or graphic instruments issued prior to the opening of Bids which clarify, correct, or change the Bidding Requirements or the proposed Contract Documents.
 2. *Agreement*—The written instrument which is evidence of the agreement between Owner and Contractor covering the Work.
 3. *Application for Payment*—The form acceptable to Engineer which is to be used by Contractor during the course of the Work in requesting progress or final payments and which is to be accompanied by such supporting documentation as is required by the Contract Documents.
 4. *Asbestos*—Any material that contains more than one percent asbestos and is friable or is releasing asbestos fibers into the air above current action levels established by the United States Occupational Safety and Health Administration.
 5. *Bid*—The offer or proposal of a Bidder submitted on the prescribed form setting forth the prices for the Work to be performed.
 6. *Bidder*—The individual or entity who submits a Bid directly to Owner.
 7. *Bidding Documents*—The Bidding Requirements and the proposed Contract Documents (including all Addenda).
 8. *Bidding Requirements*—The advertisement or invitation to bid, Instructions to Bidders, Bid security of acceptable form, if any, and the Bid Form with any supplements.
 9. *Change Order*—A document recommended by Engineer which is signed by Contractor and Owner and authorizes an addition, deletion, or revision in the Work or an adjustment in the Contract Price or the Contract Times, issued on or after the Effective Date of the Agreement.
 10. *Claim*—A demand or assertion by Owner or Contractor seeking an adjustment of Contract Price or Contract Times, or both, or other relief with respect to the terms of the Contract. A demand for money or services by a third party is not a Claim.
 11. *Contract*—The entire and integrated written agreement between the Owner and Contractor concerning the Work. The Contract supersedes prior negotiations, representations, or agreements, whether written or oral.

12. *Contract Documents*—Those items so designated in the Agreement. Only printed or hard copies of the items listed in the Agreement are Contract Documents. Approved Shop Drawings, other Contractor submittals, and the reports and drawings of subsurface and physical conditions are not Contract Documents.
13. *Contract Price*—The moneys payable by Owner to Contractor for completion of the Work in accordance with the Contract Documents as stated in the Agreement (subject to the provisions of Paragraph 11.03 in the case of Unit Price Work).
14. *Contract Times*—The number of days or the dates stated in the Agreement to: (i) achieve Milestones, if any; (ii) achieve Substantial Completion; and (iii) complete the Work so that it is ready for final payment as evidenced by Engineer's written recommendation of final payment.
15. *Contractor*—The individual or entity with whom Owner has entered into the Agreement.
16. *Cost of the Work*—See Paragraph 11.01 for definition.
17. *Drawings*—That part of the Contract Documents prepared or approved by Engineer which graphically shows the scope, extent, and character of the Work to be performed by Contractor. Shop Drawings and other Contractor submittals are not Drawings as so defined.
18. *Effective Date of the Agreement*—The date indicated in the Agreement on which it becomes effective, but if no such date is indicated, it means the date on which the Agreement is signed and delivered by the last of the two parties to sign and deliver.
19. *Engineer*—The individual or entity named as such in the Agreement.
20. *Field Order*—A written order issued by Engineer which requires minor changes in the Work but which does not involve a change in the Contract Price or the Contract Times.
21. *General Requirements*—Sections of Division 1 of the Specifications.
22. *Hazardous Environmental Condition*—The presence at the Site of Asbestos, PCBs, Petroleum, Hazardous Waste, or Radioactive Material in such quantities or circumstances that may present a substantial danger to persons or property exposed thereto.
23. *Hazardous Waste*—The term Hazardous Waste shall have the meaning provided in Section 1004 of the Solid Waste Disposal Act (42 USC Section 6903) as amended from time to time.
24. *Laws and Regulations; Laws or Regulations*—Any and all applicable laws, rules, regulations, ordinances, codes, and orders of any and all governmental bodies, agencies, authorities, and courts having jurisdiction.
25. *Liens*—Charges, security interests, or encumbrances upon Project funds, real property, or personal property.
26. *Milestone*—A principal event specified in the Contract Documents relating to an intermediate completion date or time prior to Substantial Completion of all the Work.

27. *Notice of Award*—The written notice by Owner to the Successful Bidder stating that upon timely compliance by the Successful Bidder with the conditions precedent listed therein, Owner will sign and deliver the Agreement.
28. *Notice to Proceed*—A written notice given by Owner to Contractor fixing the date on which the Contract Times will commence to run and on which Contractor shall start to perform the Work under the Contract Documents.
29. *Owner*—The individual or entity with whom Contractor has entered into the Agreement and for whom the Work is to be performed.
30. *PCBs*—Polychlorinated biphenyls.
31. *Petroleum*—Petroleum, including crude oil or any fraction thereof which is liquid at standard conditions of temperature and pressure (60 degrees Fahrenheit and 14.7 pounds per square inch absolute), such as oil, petroleum, fuel oil, oil sludge, oil refuse, gasoline, kerosene, and oil mixed with other non-Hazardous Waste and crude oils.
32. *Progress Schedule*—A schedule, prepared and maintained by Contractor, describing the sequence and duration of the activities comprising the Contractor's plan to accomplish the Work within the Contract Times.
33. *Project*—The total construction of which the Work to be performed under the Contract Documents may be the whole, or a part.
34. *Project Manual*—The bound documentary information prepared for bidding and constructing the Work. A listing of the contents of the Project Manual, which may be bound in one or more volumes, is contained in the table(s) of contents.
35. *Radioactive Material*—Source, special nuclear, or byproduct material as defined by the Atomic Energy Act of 1954 (42 USC Section 2011 et seq.) as amended from time to time.
36. *Resident Project Representative*—The authorized representative of Engineer who may be assigned to the Site or any part thereof.
37. *Samples*—Physical examples of materials, equipment, or workmanship that are representative of some portion of the Work and which establish the standards by which such portion of the Work will be judged.
38. *Schedule of Submittals*—A schedule, prepared and maintained by Contractor, of required submittals and the time requirements to support scheduled performance of related construction activities.
39. *Schedule of Values*—A schedule, prepared and maintained by Contractor, allocating portions of the Contract Price to various portions of the Work and used as the basis for reviewing Contractor's Applications for Payment.

40. *Shop Drawings*—All drawings, diagrams, illustrations, schedules, and other data or information which are specifically prepared or assembled by or for Contractor and submitted by Contractor to illustrate some portion of the Work.
41. *Site*—Lands or areas indicated in the Contract Documents as being furnished by Owner upon which the Work is to be performed, including rights-of-way and easements for access thereto, and such other lands furnished by Owner which are designated for the use of Contractor.
42. *Specifications*—That part of the Contract Documents consisting of written requirements for materials, equipment, systems, standards and workmanship as applied to the Work, and certain administrative requirements and procedural matters applicable thereto.
43. *Subcontractor*—An individual or entity having a direct contract with Contractor or with any other Subcontractor for the performance of a part of the Work at the Site.
44. *Substantial Completion*—The time at which the Work (or a specified part thereof) has progressed to the point where, in the opinion of Engineer, the Work (or a specified part thereof) is sufficiently complete, in accordance with the Contract Documents, so that the Work (or a specified part thereof) can be utilized for the purposes for which it is intended. The terms “substantially complete” and “substantially completed” as applied to all or part of the Work refer to Substantial Completion thereof.
45. *Successful Bidder*—The Bidder submitting a responsive Bid to whom Owner makes an award.
46. *Supplementary Conditions*—That part of the Contract Documents which amends or supplements these General Conditions.
47. *Supplier*—A manufacturer, fabricator, supplier, distributor, materialman, or vendor having a direct contract with Contractor or with any Subcontractor to furnish materials or equipment to be incorporated in the Work by Contractor or Subcontractor.
48. *Underground Facilities*—All underground pipelines, conduits, ducts, cables, wires, manholes, vaults, tanks, tunnels, or other such facilities or attachments, and any encasements containing such facilities, including those that convey electricity, gases, steam, liquid petroleum products, telephone or other communications, cable television, water, wastewater, storm water, other liquids or chemicals, or traffic or other control systems.
49. *Unit Price Work*—Work to be paid for on the basis of unit prices.
50. *Work*—The entire construction or the various separately identifiable parts thereof required to be provided under the Contract Documents. Work includes and is the result of performing or providing all labor, services, and documentation necessary to produce such construction, and furnishing, installing, and incorporating all materials and equipment into such construction, all as required by the Contract Documents.
51. *Work Change Directive*—A written statement to Contractor issued on or after the Effective Date of the Agreement and signed by Owner and recommended by Engineer ordering an

addition, deletion, or revision in the Work, or responding to differing or unforeseen subsurface or physical conditions under which the Work is to be performed or to emergencies. A Work Change Directive will not change the Contract Price or the Contract Times but is evidence that the parties expect that the change ordered or documented by a Work Change Directive will be incorporated in a subsequently issued Change Order following negotiations by the parties as to its effect, if any, on the Contract Price or Contract Times.

1.02 Terminology

A. The words and terms discussed in Paragraph 1.02.B through F are not defined but, when used in the Bidding Requirements or Contract Documents, have the indicated meaning.

B. *Intent of Certain Terms or Adjectives:*

1. The Contract Documents include the terms “as allowed,” “as approved,” “as ordered,” “as directed” or terms of like effect or import to authorize an exercise of professional judgment by Engineer. In addition, the adjectives “reasonable,” “suitable,” “acceptable,” “proper,” “satisfactory,” or adjectives of like effect or import are used to describe an action or determination of Engineer as to the Work. It is intended that such exercise of professional judgment, action, or determination will be solely to evaluate, in general, the Work for compliance with the information in the Contract Documents and with the design concept of the Project as a functioning whole as shown or indicated in the Contract Documents (unless there is a specific statement indicating otherwise). The use of any such term or adjective is not intended to and shall not be effective to assign to Engineer any duty or authority to supervise or direct the performance of the Work, or any duty or authority to undertake responsibility contrary to the provisions of Paragraph 9.09 or any other provision of the Contract Documents.

C. *Day:*

1. The word “day” means a calendar day of 24 hours measured from midnight to the next midnight.

D. *Defective:*

1. The word “defective,” when modifying the word “Work,” refers to Work that is unsatisfactory, faulty, or deficient in that it:
 - a. does not conform to the Contract Documents; or
 - b. does not meet the requirements of any applicable inspection, reference standard, test, or approval referred to in the Contract Documents; or
 - c. has been damaged prior to Engineer’s recommendation of final payment (unless responsibility for the protection thereof has been assumed by Owner at Substantial Completion in accordance with Paragraph 14.04 or 14.05).

E. *Furnish, Install, Perform, Provide:*

1. The word “furnish,” when used in connection with services, materials, or equipment, shall mean to supply and deliver said services, materials, or equipment to the Site (or some other specified location) ready for use or installation and in usable or operable condition.
 2. The word “install,” when used in connection with services, materials, or equipment, shall mean to put into use or place in final position said services, materials, or equipment complete and ready for intended use.
 3. The words “perform” or “provide,” when used in connection with services, materials, or equipment, shall mean to furnish and install said services, materials, or equipment complete and ready for intended use.
 4. When “furnish,” “install,” “perform,” or “provide” is not used in connection with services, materials, or equipment in a context clearly requiring an obligation of Contractor, “provide” is implied.
- F. Unless stated otherwise in the Contract Documents, words or phrases that have a well-known technical or construction industry or trade meaning are used in the Contract Documents in accordance with such recognized meaning.

ARTICLE 2 – PRELIMINARY MATTERS

2.01 Delivery of Bonds and Evidence of Insurance

- A. When Contractor delivers the executed counterparts of the Agreement to Owner, Contractor shall also deliver to Owner such bonds as Contractor may be required to furnish.
- B. *Evidence of Insurance:* Before any Work at the Site is started, Contractor and Owner shall each deliver to the other, with copies to each additional insured identified in the Supplementary Conditions, certificates of insurance (and other evidence of insurance which either of them or any additional insured may reasonably request) which Contractor and Owner respectively are required to purchase and maintain in accordance with Article 5.

2.02 Copies of Documents

- A. Owner shall furnish to Contractor up to ten printed or hard copies of the Drawings and Project Manual. Additional copies will be furnished upon request at the cost of reproduction.

2.03 Commencement of Contract Times; Notice to Proceed

- A. The Contract Times will commence to run on the thirtieth day after the Effective Date of the Agreement or, if a Notice to Proceed is given, on the day indicated in the Notice to Proceed. A Notice to Proceed may be given at any time within 30 days after the Effective Date of the Agreement. In no event will the Contract Times commence to run later than the sixtieth day after the day of Bid opening or the thirtieth day after the Effective Date of the Agreement, whichever date is earlier.

2.04 *Starting the Work*

- A. Contractor shall start to perform the Work on the date when the Contract Times commence to run. No Work shall be done at the Site prior to the date on which the Contract Times commence to run.

2.05 *Before Starting Construction*

- A. *Preliminary Schedules:* Within 10 days after the Effective Date of the Agreement (unless otherwise specified in the General Requirements), Contractor shall submit to Engineer for timely review:
 - 1. a preliminary Progress Schedule indicating the times (numbers of days or dates) for starting and completing the various stages of the Work, including any Milestones specified in the Contract Documents;
 - 2. a preliminary Schedule of Submittals; and
 - 3. a preliminary Schedule of Values for all of the Work which includes quantities and prices of items which when added together equal the Contract Price and subdivides the Work into component parts in sufficient detail to serve as the basis for progress payments during performance of the Work. Such prices will include an appropriate amount of overhead and profit applicable to each item of Work.

2.06 *Preconstruction Conference; Designation of Authorized Representatives*

- A. Before any Work at the Site is started, a conference attended by Owner, Contractor, Engineer, and others as appropriate will be held to establish a working understanding among the parties as to the Work and to discuss the schedules referred to in Paragraph 2.05.A, procedures for handling Shop Drawings and other submittals, processing Applications for Payment, and maintaining required records.
- B. At this conference Owner and Contractor each shall designate, in writing, a specific individual to act as its authorized representative with respect to the services and responsibilities under the Contract. Such individuals shall have the authority to transmit instructions, receive information, render decisions relative to the Contract, and otherwise act on behalf of each respective party.

2.07 *Initial Acceptance of Schedules*

- A. At least 10 days before submission of the first Application for Payment a conference attended by Contractor, Engineer, and others as appropriate will be held to review for acceptability to Engineer as provided below the schedules submitted in accordance with Paragraph 2.05.A. Contractor shall have an additional 10 days to make corrections and adjustments and to complete and resubmit the schedules. No progress payment shall be made to Contractor until acceptable schedules are submitted to Engineer.
 - 1. The Progress Schedule will be acceptable to Engineer if it provides an orderly progression of the Work to completion within the Contract Times. Such acceptance will not impose on Engineer responsibility for the Progress Schedule, for sequencing, scheduling, or progress of

the Work, nor interfere with or relieve Contractor from Contractor's full responsibility therefor.

2. Contractor's Schedule of Submittals will be acceptable to Engineer if it provides a workable arrangement for reviewing and processing the required submittals.
3. Contractor's Schedule of Values will be acceptable to Engineer as to form and substance if it provides a reasonable allocation of the Contract Price to component parts of the Work.

ARTICLE 3 – CONTRACT DOCUMENTS: INTENT, AMENDING, REUSE

3.01 *Intent*

- A. The Contract Documents are complementary; what is required by one is as binding as if required by all.
- B. It is the intent of the Contract Documents to describe a functionally complete project (or part thereof) to be constructed in accordance with the Contract Documents. Any labor, documentation, services, materials, or equipment that reasonably may be inferred from the Contract Documents or from prevailing custom or trade usage as being required to produce the indicated result will be provided whether or not specifically called for, at no additional cost to Owner.
- C. Clarifications and interpretations of the Contract Documents shall be issued by Engineer as provided in Article 9.

3.02 *Reference Standards*

- A. Standards, Specifications, Codes, Laws, and Regulations
 1. Reference to standards, specifications, manuals, or codes of any technical society, organization, or association, or to Laws or Regulations, whether such reference be specific or by implication, shall mean the standard, specification, manual, code, or Laws or Regulations in effect at the time of opening of Bids (or on the Effective Date of the Agreement if there were no Bids), except as may be otherwise specifically stated in the Contract Documents.
 2. No provision of any such standard, specification, manual, or code, or any instruction of a Supplier, shall be effective to change the duties or responsibilities of Owner, Contractor, or Engineer, or any of their subcontractors, consultants, agents, or employees, from those set forth in the Contract Documents. No such provision or instruction shall be effective to assign to Owner, Engineer, or any of their officers, directors, members, partners, employees, agents, consultants, or subcontractors, any duty or authority to supervise or direct the performance of the Work or any duty or authority to undertake responsibility inconsistent with the provisions of the Contract Documents.

3.03 *Reporting and Resolving Discrepancies*

- A. *Reporting Discrepancies:*

1. *Contractor's Review of Contract Documents Before Starting Work:* Before undertaking each part of the Work, Contractor shall carefully study and compare the Contract Documents and check and verify pertinent figures therein and all applicable field measurements. Contractor shall promptly report in writing to Engineer any conflict, error, ambiguity, or discrepancy which Contractor discovers, or has actual knowledge of, and shall obtain a written interpretation or clarification from Engineer before proceeding with any Work affected thereby.
2. *Contractor's Review of Contract Documents During Performance of Work:* If, during the performance of the Work, Contractor discovers any conflict, error, ambiguity, or discrepancy within the Contract Documents, or between the Contract Documents and (a) any applicable Law or Regulation, (b) any standard, specification, manual, or code, or (c) any instruction of any Supplier, then Contractor shall promptly report it to Engineer in writing. Contractor shall not proceed with the Work affected thereby (except in an emergency as required by Paragraph 6.16.A) until an amendment or supplement to the Contract Documents has been issued by one of the methods indicated in Paragraph 3.04.
3. Contractor shall not be liable to Owner or Engineer for failure to report any conflict, error, ambiguity, or discrepancy in the Contract Documents unless Contractor had actual knowledge thereof.

B. *Resolving Discrepancies:*

1. Except as may be otherwise specifically stated in the Contract Documents, the provisions of the Contract Documents shall take precedence in resolving any conflict, error, ambiguity, or discrepancy between the provisions of the Contract Documents and:
 - a. the provisions of any standard, specification, manual, or code, or the instruction of any Supplier (whether or not specifically incorporated by reference in the Contract Documents); or
 - b. the provisions of any Laws or Regulations applicable to the performance of the Work (unless such an interpretation of the provisions of the Contract Documents would result in violation of such Law or Regulation).

3.04 *Amending and Supplementing Contract Documents*

- A. The Contract Documents may be amended to provide for additions, deletions, and revisions in the Work or to modify the terms and conditions thereof by either a Change Order or a Work Change Directive.
- B. The requirements of the Contract Documents may be supplemented, and minor variations and deviations in the Work may be authorized, by one or more of the following ways:
 1. A Field Order;
 2. Engineer's approval of a Shop Drawing or Sample (subject to the provisions of Paragraph 6.17.D.3); or

3. Engineer's written interpretation or clarification.

3.05 *Reuse of Documents*

- A. Contractor and any Subcontractor or Supplier shall not:
 1. have or acquire any title to or ownership rights in any of the Drawings, Specifications, or other documents (or copies of any thereof) prepared by or bearing the seal of Engineer or its consultants, including electronic media editions; or
 2. reuse any such Drawings, Specifications, other documents, or copies thereof on extensions of the Project or any other project without written consent of Owner and Engineer and specific written verification or adaptation by Engineer.
- B. The prohibitions of this Paragraph 3.05 will survive final payment, or termination of the Contract. Nothing herein shall preclude Contractor from retaining copies of the Contract Documents for record purposes.

3.06 *Electronic Data*

- A. Unless otherwise stated in the Supplementary Conditions, the data furnished by Owner or Engineer to Contractor, or by Contractor to Owner or Engineer, that may be relied upon are limited to the printed copies (also known as hard copies). Files in electronic media format of text, data, graphics, or other types are furnished only for the convenience of the receiving party. Any conclusion or information obtained or derived from such electronic files will be at the user's sole risk. If there is a discrepancy between the electronic files and the hard copies, the hard copies govern.
- B. Because data stored in electronic media format can deteriorate or be modified inadvertently or otherwise without authorization of the data's creator, the party receiving electronic files agrees that it will perform acceptance tests or procedures within 60 days, after which the receiving party shall be deemed to have accepted the data thus transferred. Any errors detected within the 60-day acceptance period will be corrected by the transferring party.
- C. When transferring documents in electronic media format, the transferring party makes no representations as to long term compatibility, usability, or readability of documents resulting from the use of software application packages, operating systems, or computer hardware differing from those used by the data's creator.

ARTICLE 4 – AVAILABILITY OF LANDS; SUBSURFACE AND PHYSICAL CONDITIONS; HAZARDOUS ENVIRONMENTAL CONDITIONS; REFERENCE POINTS

4.01 *Availability of Lands*

- A. Owner shall furnish the Site. Owner shall notify Contractor of any encumbrances or restrictions not of general application but specifically related to use of the Site with which Contractor must comply in performing the Work. Owner will obtain in a timely manner and pay for easements for permanent structures or permanent changes in existing facilities. If Contractor and Owner are unable to agree on entitlement to or on the amount or extent, if any, of any adjustment in the

Contract Price or Contract Times, or both, as a result of any delay in Owner's furnishing the Site or a part thereof, Contractor may make a Claim therefor as provided in Paragraph 10.05.

- B. Upon reasonable written request, Owner shall furnish Contractor with a current statement of record legal title and legal description of the lands upon which the Work is to be performed and Owner's interest therein as necessary for giving notice of or filing a mechanic's or construction lien against such lands in accordance with applicable Laws and Regulations.
- C. Contractor shall provide for all additional lands and access thereto that may be required for temporary construction facilities or storage of materials and equipment.

4.02 *Subsurface and Physical Conditions*

A. *Reports and Drawings:* The Supplementary Conditions identify:

- 1. those reports known to Owner of explorations and tests of subsurface conditions at or contiguous to the Site; and
- 2. those drawings known to Owner of physical conditions relating to existing surface or subsurface structures at the Site (except Underground Facilities).

B. *Limited Reliance by Contractor on Technical Data Authorized:* Contractor may rely upon the accuracy of the "technical data" contained in such reports and drawings, but such reports and drawings are not Contract Documents. Such "technical data" is identified in the Supplementary Conditions. Except for such reliance on such "technical data," Contractor may not rely upon or make any claim against Owner or Engineer, or any of their officers, directors, members, partners, employees, agents, consultants, or subcontractors with respect to:

- 1. the completeness of such reports and drawings for Contractor's purposes, including, but not limited to, any aspects of the means, methods, techniques, sequences, and procedures of construction to be employed by Contractor, and safety precautions and programs incident thereto; or
- 2. other data, interpretations, opinions, and information contained in such reports or shown or indicated in such drawings; or
- 3. any Contractor interpretation of or conclusion drawn from any "technical data" or any such other data, interpretations, opinions, or information.

4.03 *Differing Subsurface or Physical Conditions*

A. *Notice:* If Contractor believes that any subsurface or physical condition that is uncovered or revealed either:

- 1. is of such a nature as to establish that any "technical data" on which Contractor is entitled to rely as provided in Paragraph 4.02 is materially inaccurate; or
- 2. is of such a nature as to require a change in the Contract Documents; or

3. differs materially from that shown or indicated in the Contract Documents; or
4. is of an unusual nature, and differs materially from conditions ordinarily encountered and generally recognized as inherent in work of the character provided for in the Contract Documents;

then Contractor shall, promptly after becoming aware thereof and before further disturbing the subsurface or physical conditions or performing any Work in connection therewith (except in an emergency as required by Paragraph 6.16.A), notify Owner and Engineer in writing about such condition. Contractor shall not further disturb such condition or perform any Work in connection therewith (except as aforesaid) until receipt of written order to do so.

B. *Engineer's Review:* After receipt of written notice as required by Paragraph 4.03.A, Engineer will promptly review the pertinent condition, determine the necessity of Owner's obtaining additional exploration or tests with respect thereto, and advise Owner in writing (with a copy to Contractor) of Engineer's findings and conclusions.

C. *Possible Price and Times Adjustments:*

1. The Contract Price or the Contract Times, or both, will be equitably adjusted to the extent that the existence of such differing subsurface or physical condition causes an increase or decrease in Contractor's cost of, or time required for, performance of the Work; subject, however, to the following:
 - a. such condition must meet any one or more of the categories described in Paragraph 4.03.A; and
 - b. with respect to Work that is paid for on a unit price basis, any adjustment in Contract Price will be subject to the provisions of Paragraphs 9.07 and 11.03.
2. Contractor shall not be entitled to any adjustment in the Contract Price or Contract Times if:
 - a. Contractor knew of the existence of such conditions at the time Contractor made a final commitment to Owner with respect to Contract Price and Contract Times by the submission of a Bid or becoming bound under a negotiated contract; or
 - b. the existence of such condition could reasonably have been discovered or revealed as a result of any examination, investigation, exploration, test, or study of the Site and contiguous areas required by the Bidding Requirements or Contract Documents to be conducted by or for Contractor prior to Contractor's making such final commitment; or
 - c. Contractor failed to give the written notice as required by Paragraph 4.03.A.
3. If Owner and Contractor are unable to agree on entitlement to or on the amount or extent, if any, of any adjustment in the Contract Price or Contract Times, or both, a Claim may be made therefor as provided in Paragraph 10.05. However, neither Owner or Engineer, or any of their officers, directors, members, partners, employees, agents, consultants, or subcontractors shall be liable to Contractor for any claims, costs, losses, or damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other

professionals and all court or arbitration or other dispute resolution costs) sustained by Contractor on or in connection with any other project or anticipated project.

4.04 *Underground Facilities*

A. *Shown or Indicated:* The information and data shown or indicated in the Contract Documents with respect to existing Underground Facilities at or contiguous to the Site is based on information and data furnished to Owner or Engineer by the owners of such Underground Facilities, including Owner, or by others. Unless it is otherwise expressly provided in the Supplementary Conditions:

1. Owner and Engineer shall not be responsible for the accuracy or completeness of any such information or data provided by others; and
2. the cost of all of the following will be included in the Contract Price, and Contractor shall have full responsibility for:
 - a. reviewing and checking all such information and data;
 - b. locating all Underground Facilities shown or indicated in the Contract Documents;
 - c. coordination of the Work with the owners of such Underground Facilities, including Owner, during construction; and
 - d. the safety and protection of all such Underground Facilities and repairing any damage thereto resulting from the Work.

B. *Not Shown or Indicated:*

1. If an Underground Facility is uncovered or revealed at or contiguous to the Site which was not shown or indicated, or not shown or indicated with reasonable accuracy in the Contract Documents, Contractor shall, promptly after becoming aware thereof and before further disturbing conditions affected thereby or performing any Work in connection therewith (except in an emergency as required by Paragraph 6.16.A), identify the owner of such Underground Facility and give written notice to that owner and to Owner and Engineer. Engineer will promptly review the Underground Facility and determine the extent, if any, to which a change is required in the Contract Documents to reflect and document the consequences of the existence or location of the Underground Facility. During such time, Contractor shall be responsible for the safety and protection of such Underground Facility.
2. If Engineer concludes that a change in the Contract Documents is required, a Work Change Directive or a Change Order will be issued to reflect and document such consequences. An equitable adjustment shall be made in the Contract Price or Contract Times, or both, to the extent that they are attributable to the existence or location of any Underground Facility that was not shown or indicated or not shown or indicated with reasonable accuracy in the Contract Documents and that Contractor did not know of and could not reasonably have been expected to be aware of or to have anticipated. If Owner and Contractor are unable to agree on entitlement to or on the amount or extent, if any, of any such adjustment in Contract Price

or Contract Times, Owner or Contractor may make a Claim therefor as provided in Paragraph 10.05.

4.05 *Reference Points*

- A. Owner shall provide engineering surveys to establish reference points for construction which in Engineer's judgment are necessary to enable Contractor to proceed with the Work. Contractor shall be responsible for laying out the Work, shall protect and preserve the established reference points and property monuments, and shall make no changes or relocations without the prior written approval of Owner. Contractor shall report to Engineer whenever any reference point or property monument is lost or destroyed or requires relocation because of necessary changes in grades or locations, and shall be responsible for the accurate replacement or relocation of such reference points or property monuments by professionally qualified personnel.

4.06 *Hazardous Environmental Condition at Site*

- A. *Reports and Drawings:* The Supplementary Conditions identify those reports and drawings known to Owner relating to Hazardous Environmental Conditions that have been identified at the Site.
- B. *Limited Reliance by Contractor on Technical Data Authorized:* Contractor may rely upon the accuracy of the "technical data" contained in such reports and drawings, but such reports and drawings are not Contract Documents. Such "technical data" is identified in the Supplementary Conditions. Except for such reliance on such "technical data," Contractor may not rely upon or make any claim against Owner or Engineer, or any of their officers, directors, members, partners, employees, agents, consultants, or subcontractors with respect to:
1. the completeness of such reports and drawings for Contractor's purposes, including, but not limited to, any aspects of the means, methods, techniques, sequences and procedures of construction to be employed by Contractor and safety precautions and programs incident thereto; or
 2. other data, interpretations, opinions and information contained in such reports or shown or indicated in such drawings; or
 3. any Contractor interpretation of or conclusion drawn from any "technical data" or any such other data, interpretations, opinions or information.
- C. Contractor shall not be responsible for any Hazardous Environmental Condition uncovered or revealed at the Site which was not shown or indicated in Drawings or Specifications or identified in the Contract Documents to be within the scope of the Work. Contractor shall be responsible for a Hazardous Environmental Condition created with any materials brought to the Site by Contractor, Subcontractors, Suppliers, or anyone else for whom Contractor is responsible.
- D. If Contractor encounters a Hazardous Environmental Condition or if Contractor or anyone for whom Contractor is responsible creates a Hazardous Environmental Condition, Contractor shall immediately: (i) secure or otherwise isolate such condition; (ii) stop all Work in connection with such condition and in any area affected thereby (except in an emergency as required by

Paragraph 6.16.A); and (iii) notify Owner and Engineer (and promptly thereafter confirm such notice in writing). Owner shall promptly consult with Engineer concerning the necessity for Owner to retain a qualified expert to evaluate such condition or take corrective action, if any. Promptly after consulting with Engineer, Owner shall take such actions as are necessary to permit Owner to timely obtain required permits and provide Contractor the written notice required by Paragraph 4.06.E.

- E. Contractor shall not be required to resume Work in connection with such condition or in any affected area until after Owner has obtained any required permits related thereto and delivered written notice to Contractor: (i) specifying that such condition and any affected area is or has been rendered safe for the resumption of Work; or (ii) specifying any special conditions under which such Work may be resumed safely. If Owner and Contractor cannot agree as to entitlement to or on the amount or extent, if any, of any adjustment in Contract Price or Contract Times, or both, as a result of such Work stoppage or such special conditions under which Work is agreed to be resumed by Contractor, either party may make a Claim therefor as provided in Paragraph 10.05.
- F. If after receipt of such written notice Contractor does not agree to resume such Work based on a reasonable belief it is unsafe, or does not agree to resume such Work under such special conditions, then Owner may order the portion of the Work that is in the area affected by such condition to be deleted from the Work. If Owner and Contractor cannot agree as to entitlement to or on the amount or extent, if any, of an adjustment in Contract Price or Contract Times as a result of deleting such portion of the Work, then either party may make a Claim therefor as provided in Paragraph 10.05. Owner may have such deleted portion of the Work performed by Owner's own forces or others in accordance with Article 7.
- G. To the fullest extent permitted by Laws and Regulations, Owner shall indemnify and hold harmless Contractor, Subcontractors, and Engineer, and the officers, directors, members, partners, employees, agents, consultants, and subcontractors of each and any of them from and against all claims, costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) arising out of or relating to a Hazardous Environmental Condition, provided that such Hazardous Environmental Condition: (i) was not shown or indicated in the Drawings or Specifications or identified in the Contract Documents to be included within the scope of the Work, and (ii) was not created by Contractor or by anyone for whom Contractor is responsible. Nothing in this Paragraph 4.06.G shall obligate Owner to indemnify any individual or entity from and against the consequences of that individual's or entity's own negligence.
- H. To the fullest extent permitted by Laws and Regulations, Contractor shall indemnify and hold harmless Owner and Engineer, and the officers, directors, members, partners, employees, agents, consultants, and subcontractors of each and any of them from and against all claims, costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) arising out of or relating to a Hazardous Environmental Condition created by Contractor or by anyone for whom Contractor is responsible. Nothing in this Paragraph 4.06.H shall obligate Contractor to indemnify any individual or entity from and against the consequences of that individual's or entity's own negligence.

- I. The provisions of Paragraphs 4.02, 4.03, and 4.04 do not apply to a Hazardous Environmental Condition uncovered or revealed at the Site.

ARTICLE 5 – BONDS AND INSURANCE

5.01 *Performance, Payment, and Other Bonds*

- A. Contractor shall furnish performance and payment bonds, each in an amount at least equal to the Contract Price as security for the faithful performance and payment of all of Contractor's obligations under the Contract Documents. These bonds shall remain in effect until one year after the date when final payment becomes due or until completion of the correction period specified in Paragraph 13.07, whichever is later, except as provided otherwise by Laws or Regulations or by the Contract Documents. Contractor shall also furnish such other bonds as are required by the Contract Documents.
- B. All bonds shall be in the form prescribed by the Contract Documents except as provided otherwise by Laws or Regulations, and shall be executed by such sureties as are named in the list of "Companies Holding Certificates of Authority as Acceptable Sureties on Federal Bonds and as Acceptable Reinsuring Companies" as published in Circular 570 (amended) by the Financial Management Service, Surety Bond Branch, U.S. Department of the Treasury. All bonds signed by an agent or attorney-in-fact must be accompanied by a certified copy of that individual's authority to bind the surety. The evidence of authority shall show that it is effective on the date the agent or attorney-in-fact signed each bond.
- C. If the surety on any bond furnished by Contractor is declared bankrupt or becomes insolvent or its right to do business is terminated in any state where any part of the Project is located or it ceases to meet the requirements of Paragraph 5.01.B, Contractor shall promptly notify Owner and Engineer and shall, within 20 days after the event giving rise to such notification, provide another bond and surety, both of which shall comply with the requirements of Paragraphs 5.01.B and 5.02.

5.02 *Licensed Sureties and Insurers*

- A. All bonds and insurance required by the Contract Documents to be purchased and maintained by Owner or Contractor shall be obtained from surety or insurance companies that are duly licensed or authorized in the jurisdiction in which the Project is located to issue bonds or insurance policies for the limits and coverages so required. Such surety and insurance companies shall also meet such additional requirements and qualifications as may be provided in the Supplementary Conditions.

5.03 *Certificates of Insurance*

- A. Contractor shall deliver to Owner, with copies to each additional insured and loss payee identified in the Supplementary Conditions, certificates of insurance (and other evidence of insurance requested by Owner or any other additional insured) which Contractor is required to purchase and maintain.

- B. Owner shall deliver to Contractor, with copies to each additional insured and loss payee identified in the Supplementary Conditions, certificates of insurance (and other evidence of insurance requested by Contractor or any other additional insured) which Owner is required to purchase and maintain.
- C. Failure of Owner to demand such certificates or other evidence of Contractor's full compliance with these insurance requirements or failure of Owner to identify a deficiency in compliance from the evidence provided shall not be construed as a waiver of Contractor's obligation to maintain such insurance.
- D. Owner does not represent that insurance coverage and limits established in this Contract necessarily will be adequate to protect Contractor.
- E. The insurance and insurance limits required herein shall not be deemed as a limitation on Contractor's liability under the indemnities granted to Owner in the Contract Documents.

5.04 *Contractor's Insurance*

- A. Contractor shall purchase and maintain such insurance as is appropriate for the Work being performed and as will provide protection from claims set forth below which may arise out of or result from Contractor's performance of the Work and Contractor's other obligations under the Contract Documents, whether it is to be performed by Contractor, any Subcontractor or Supplier, or by anyone directly or indirectly employed by any of them to perform any of the Work, or by anyone for whose acts any of them may be liable:
 - 1. claims under workers' compensation, disability benefits, and other similar employee benefit acts;
 - 2. claims for damages because of bodily injury, occupational sickness or disease, or death of Contractor's employees;
 - 3. claims for damages because of bodily injury, sickness or disease, or death of any person other than Contractor's employees;
 - 4. claims for damages insured by reasonably available personal injury liability coverage which are sustained:
 - a. by any person as a result of an offense directly or indirectly related to the employment of such person by Contractor, or
 - b. by any other person for any other reason;
 - 5. claims for damages, other than to the Work itself, because of injury to or destruction of tangible property wherever located, including loss of use resulting therefrom; and
 - 6. claims for damages because of bodily injury or death of any person or property damage arising out of the ownership, maintenance or use of any motor vehicle.
- B. The policies of insurance required by this Paragraph 5.04 shall:

1. with respect to insurance required by Paragraphs 5.04.A.3 through 5.04.A.6 inclusive, be written on an occurrence basis, include as additional insureds (subject to any customary exclusion regarding professional liability) Owner and Engineer, and any other individuals or entities identified in the Supplementary Conditions, all of whom shall be listed as additional insureds, and include coverage for the respective officers, directors, members, partners, employees, agents, consultants, and subcontractors of each and any of all such additional insureds, and the insurance afforded to these additional insureds shall provide primary coverage for all claims covered thereby;
2. include at least the specific coverages and be written for not less than the limits of liability provided in the Supplementary Conditions or required by Laws or Regulations, whichever is greater;
3. include contractual liability insurance covering Contractor's indemnity obligations under Paragraphs 6.11 and 6.20;
4. contain a provision or endorsement that the coverage afforded will not be canceled, materially changed or renewal refused until at least 30 days prior written notice has been given to Owner and Contractor and to each other additional insured identified in the Supplementary Conditions to whom a certificate of insurance has been issued (and the certificates of insurance furnished by the Contractor pursuant to Paragraph 5.03 will so provide);
5. remain in effect at least until final payment and at all times thereafter when Contractor may be correcting, removing, or replacing defective Work in accordance with Paragraph 13.07; and
6. include completed operations coverage:
 - a. Such insurance shall remain in effect for two years after final payment.
 - b. Contractor shall furnish Owner and each other additional insured identified in the Supplementary Conditions, to whom a certificate of insurance has been issued, evidence satisfactory to Owner and any such additional insured of continuation of such insurance at final payment and one year thereafter.

5.05 *Owner's Liability Insurance*

- A. In addition to the insurance required to be provided by Contractor under Paragraph 5.04, Owner, at Owner's option, may purchase and maintain at Owner's expense Owner's own liability insurance as will protect Owner against claims which may arise from operations under the Contract Documents.

5.06 *Property Insurance*

- A. Unless otherwise provided in the Supplementary Conditions, Owner shall purchase and maintain property insurance upon the Work at the Site in the amount of the full replacement cost thereof (subject to such deductible amounts as may be provided in the Supplementary Conditions or required by Laws and Regulations). This insurance shall:

1. include the interests of Owner, Contractor, Subcontractors, and Engineer, and any other individuals or entities identified in the Supplementary Conditions, and the officers, directors, members, partners, employees, agents, consultants, and subcontractors of each and any of them, each of whom is deemed to have an insurable interest and shall be listed as a loss payee;
 2. be written on a Builder's Risk "all-risk" policy form that shall at least include insurance for physical loss or damage to the Work, temporary buildings, falsework, and materials and equipment in transit, and shall insure against at least the following perils or causes of loss: fire, lightning, extended coverage, theft, vandalism and malicious mischief, earthquake, collapse, debris removal, demolition occasioned by enforcement of Laws and Regulations, water damage (other than that caused by flood), and such other perils or causes of loss as may be specifically required by the Supplementary Conditions.
 3. include expenses incurred in the repair or replacement of any insured property (including but not limited to fees and charges of engineers and architects);
 4. cover materials and equipment stored at the Site or at another location that was agreed to in writing by Owner prior to being incorporated in the Work, provided that such materials and equipment have been included in an Application for Payment recommended by Engineer;
 5. allow for partial utilization of the Work by Owner;
 6. include testing and startup; and
 7. be maintained in effect until final payment is made unless otherwise agreed to in writing by Owner, Contractor, and Engineer with 30 days written notice to each other loss payee to whom a certificate of insurance has been issued.
- B. Owner shall purchase and maintain such equipment breakdown insurance or additional property insurance as may be required by the Supplementary Conditions or Laws and Regulations which will include the interests of Owner, Contractor, Subcontractors, and Engineer, and any other individuals or entities identified in the Supplementary Conditions, and the officers, directors, members, partners, employees, agents, consultants and subcontractors of each and any of them, each of whom is deemed to have an insurable interest and shall be listed as a loss payee.
- C. All the policies of insurance (and the certificates or other evidence thereof) required to be purchased and maintained in accordance with this Paragraph 5.06 will contain a provision or endorsement that the coverage afforded will not be canceled or materially changed or renewal refused until at least 30 days prior written notice has been given to Owner and Contractor and to each other loss payee to whom a certificate of insurance has been issued and will contain waiver provisions in accordance with Paragraph 5.07.
- D. Owner shall not be responsible for purchasing and maintaining any property insurance specified in this Paragraph 5.06 to protect the interests of Contractor, Subcontractors, or others in the Work to the extent of any deductible amounts that are identified in the Supplementary Conditions. The risk of loss within such identified deductible amount will be borne by Contractor, Subcontractors, or others suffering any such loss, and if any of them wishes property

insurance coverage within the limits of such amounts, each may purchase and maintain it at the purchaser's own expense.

- E. If Contractor requests in writing that other special insurance be included in the property insurance policies provided under this Paragraph 5.06, Owner shall, if possible, include such insurance, and the cost thereof will be charged to Contractor by appropriate Change Order. Prior to commencement of the Work at the Site, Owner shall in writing advise Contractor whether or not such other insurance has been procured by Owner.

5.07 *Waiver of Rights*

- A. Owner and Contractor intend that all policies purchased in accordance with Paragraph 5.06 will protect Owner, Contractor, Subcontractors, and Engineer, and all other individuals or entities identified in the Supplementary Conditions as loss payees (and the officers, directors, members, partners, employees, agents, consultants, and subcontractors of each and any of them) in such policies and will provide primary coverage for all losses and damages caused by the perils or causes of loss covered thereby. All such policies shall contain provisions to the effect that in the event of payment of any loss or damage the insurers will have no rights of recovery against any of the insureds or loss payees thereunder. Owner and Contractor waive all rights against each other and their respective officers, directors, members, partners, employees, agents, consultants and subcontractors of each and any of them for all losses and damages caused by, arising out of or resulting from any of the perils or causes of loss covered by such policies and any other property insurance applicable to the Work; and, in addition, waive all such rights against Subcontractors and Engineer, and all other individuals or entities identified in the Supplementary Conditions as loss payees (and the officers, directors, members, partners, employees, agents, consultants, and subcontractors of each and any of them) under such policies for losses and damages so caused. None of the above waivers shall extend to the rights that any party making such waiver may have to the proceeds of insurance held by Owner as trustee or otherwise payable under any policy so issued.
- B. Owner waives all rights against Contractor, Subcontractors, and Engineer, and the officers, directors, members, partners, employees, agents, consultants and subcontractors of each and any of them for:
 - 1. loss due to business interruption, loss of use, or other consequential loss extending beyond direct physical loss or damage to Owner's property or the Work caused by, arising out of, or resulting from fire or other perils whether or not insured by Owner; and
 - 2. loss or damage to the completed Project or part thereof caused by, arising out of, or resulting from fire or other insured peril or cause of loss covered by any property insurance maintained on the completed Project or part thereof by Owner during partial utilization pursuant to Paragraph 14.05, after Substantial Completion pursuant to Paragraph 14.04, or after final payment pursuant to Paragraph 14.07.
- C. Any insurance policy maintained by Owner covering any loss, damage or consequential loss referred to in Paragraph 5.07.B shall contain provisions to the effect that in the event of payment of any such loss, damage, or consequential loss, the insurers will have no rights of recovery

against Contractor, Subcontractors, or Engineer, and the officers, directors, members, partners, employees, agents, consultants and subcontractors of each and any of them.

5.08 *Receipt and Application of Insurance Proceeds*

- A. Any insured loss under the policies of insurance required by Paragraph 5.06 will be adjusted with Owner and made payable to Owner as fiduciary for the loss payees, as their interests may appear, subject to the requirements of any applicable mortgage clause and of Paragraph 5.08.B. Owner shall deposit in a separate account any money so received and shall distribute it in accordance with such agreement as the parties in interest may reach. If no other special agreement is reached, the damaged Work shall be repaired or replaced, the moneys so received applied on account thereof, and the Work and the cost thereof covered by an appropriate Change Order.
- B. Owner as fiduciary shall have power to adjust and settle any loss with the insurers unless one of the parties in interest shall object in writing within 15 days after the occurrence of loss to Owner's exercise of this power. If such objection be made, Owner as fiduciary shall make settlement with the insurers in accordance with such agreement as the parties in interest may reach. If no such agreement among the parties in interest is reached, Owner as fiduciary shall adjust and settle the loss with the insurers and, if required in writing by any party in interest, Owner as fiduciary shall give bond for the proper performance of such duties.

5.09 *Acceptance of Bonds and Insurance; Option to Replace*

- A. If either Owner or Contractor has any objection to the coverage afforded by or other provisions of the bonds or insurance required to be purchased and maintained by the other party in accordance with Article 5 on the basis of non-conformance with the Contract Documents, the objecting party shall so notify the other party in writing within 10 days after receipt of the certificates (or other evidence requested) required by Paragraph 2.01.B. Owner and Contractor shall each provide to the other such additional information in respect of insurance provided as the other may reasonably request. If either party does not purchase or maintain all of the bonds and insurance required of such party by the Contract Documents, such party shall notify the other party in writing of such failure to purchase prior to the start of the Work, or of such failure to maintain prior to any change in the required coverage. Without prejudice to any other right or remedy, the other party may elect to obtain equivalent bonds or insurance to protect such other party's interests at the expense of the party who was required to provide such coverage, and a Change Order shall be issued to adjust the Contract Price accordingly.

5.10 *Partial Utilization, Acknowledgment of Property Insurer*

- A. If Owner finds it necessary to occupy or use a portion or portions of the Work prior to Substantial Completion of all the Work as provided in Paragraph 14.05, no such use or occupancy shall commence before the insurers providing the property insurance pursuant to Paragraph 5.06 have acknowledged notice thereof and in writing effected any changes in coverage necessitated thereby. The insurers providing the property insurance shall consent by endorsement on the policy or policies, but the property insurance shall not be canceled or permitted to lapse on account of any such partial use or occupancy.

ARTICLE 6 – CONTRACTOR’S RESPONSIBILITIES

6.01 *Supervision and Superintendence*

- A. Contractor shall supervise, inspect, and direct the Work competently and efficiently, devoting such attention thereto and applying such skills and expertise as may be necessary to perform the Work in accordance with the Contract Documents. Contractor shall be solely responsible for the means, methods, techniques, sequences, and procedures of construction. Contractor shall not be responsible for the negligence of Owner or Engineer in the design or specification of a specific means, method, technique, sequence, or procedure of construction which is shown or indicated in and expressly required by the Contract Documents.
- B. At all times during the progress of the Work, Contractor shall assign a competent resident superintendent who shall not be replaced without written notice to Owner and Engineer except under extraordinary circumstances.

6.02 *Labor; Working Hours*

- A. Contractor shall provide competent, suitably qualified personnel to survey and lay out the Work and perform construction as required by the Contract Documents. Contractor shall at all times maintain good discipline and order at the Site.
- B. Except as otherwise required for the safety or protection of persons or the Work or property at the Site or adjacent thereto, and except as otherwise stated in the Contract Documents, all Work at the Site shall be performed during regular working hours. Contractor will not permit the performance of Work on a Saturday, Sunday, or any legal holiday without Owner’s written consent (which will not be unreasonably withheld) given after prior written notice to Engineer.

6.03 *Services, Materials, and Equipment*

- A. Unless otherwise specified in the Contract Documents, Contractor shall provide and assume full responsibility for all services, materials, equipment, labor, transportation, construction equipment and machinery, tools, appliances, fuel, power, light, heat, telephone, water, sanitary facilities, temporary facilities, and all other facilities and incidentals necessary for the performance, testing, start-up, and completion of the Work.
- B. All materials and equipment incorporated into the Work shall be as specified or, if not specified, shall be of good quality and new, except as otherwise provided in the Contract Documents. All special warranties and guarantees required by the Specifications shall expressly run to the benefit of Owner. If required by Engineer, Contractor shall furnish satisfactory evidence (including reports of required tests) as to the source, kind, and quality of materials and equipment.
- C. All materials and equipment shall be stored, applied, installed, connected, erected, protected, used, cleaned, and conditioned in accordance with instructions of the applicable Supplier, except as otherwise may be provided in the Contract Documents.

6.04 *Progress Schedule*

- A. Contractor shall adhere to the Progress Schedule established in accordance with Paragraph 2.07 as it may be adjusted from time to time as provided below.
1. Contractor shall submit to Engineer for acceptance (to the extent indicated in Paragraph 2.07) proposed adjustments in the Progress Schedule that will not result in changing the Contract Times. Such adjustments will comply with any provisions of the General Requirements applicable thereto.
 2. Proposed adjustments in the Progress Schedule that will change the Contract Times shall be submitted in accordance with the requirements of Article 12. Adjustments in Contract Times may only be made by a Change Order.

6.05 *Substitutes and "Or-Equals"*

- A. Whenever an item of material or equipment is specified or described in the Contract Documents by using the name of a proprietary item or the name of a particular Supplier, the specification or description is intended to establish the type, function, appearance, and quality required. Unless the specification or description contains or is followed by words reading that no like, equivalent, or "or-equal" item or no substitution is permitted, other items of material or equipment or material or equipment of other Suppliers may be submitted to Engineer for review under the circumstances described below.
1. *"Or-Equal" Items:* If in Engineer's sole discretion an item of material or equipment proposed by Contractor is functionally equal to that named and sufficiently similar so that no change in related Work will be required, it may be considered by Engineer as an "or-equal" item, in which case review and approval of the proposed item may, in Engineer's sole discretion, be accomplished without compliance with some or all of the requirements for approval of proposed substitute items. For the purposes of this Paragraph 6.05.A.1, a proposed item of material or equipment will be considered functionally equal to an item so named if:
 - a. in the exercise of reasonable judgment Engineer determines that:
 - 1) it is at least equal in materials of construction, quality, durability, appearance, strength, and design characteristics;
 - 2) it will reliably perform at least equally well the function and achieve the results imposed by the design concept of the completed Project as a functioning whole; and
 - 3) it has a proven record of performance and availability of responsive service.
 - b. Contractor certifies that, if approved and incorporated into the Work:
 - 1) there will be no increase in cost to the Owner or increase in Contract Times; and
 - 2) it will conform substantially to the detailed requirements of the item named in the Contract Documents.

2. *Substitute Items:*

- a. If in Engineer's sole discretion an item of material or equipment proposed by Contractor does not qualify as an "or-equal" item under Paragraph 6.05.A.1, it will be considered a proposed substitute item.
- b. Contractor shall submit sufficient information as provided below to allow Engineer to determine if the item of material or equipment proposed is essentially equivalent to that named and an acceptable substitute therefor. Requests for review of proposed substitute items of material or equipment will not be accepted by Engineer from anyone other than Contractor.
- c. The requirements for review by Engineer will be as set forth in Paragraph 6.05.A.2.d, as supplemented by the General Requirements, and as Engineer may decide is appropriate under the circumstances.
- d. Contractor shall make written application to Engineer for review of a proposed substitute item of material or equipment that Contractor seeks to furnish or use. The application:
 - 1) shall certify that the proposed substitute item will:
 - a) perform adequately the functions and achieve the results called for by the general design,
 - b) be similar in substance to that specified, and
 - c) be suited to the same use as that specified;
 - 2) will state:
 - a) the extent, if any, to which the use of the proposed substitute item will prejudice Contractor's achievement of Substantial Completion on time,
 - b) whether use of the proposed substitute item in the Work will require a change in any of the Contract Documents (or in the provisions of any other direct contract with Owner for other work on the Project) to adapt the design to the proposed substitute item, and
 - c) whether incorporation or use of the proposed substitute item in connection with the Work is subject to payment of any license fee or royalty;
 - 3) will identify:
 - a) all variations of the proposed substitute item from that specified, and
 - b) available engineering, sales, maintenance, repair, and replacement services; and

- 4) shall contain an itemized estimate of all costs or credits that will result directly or indirectly from use of such substitute item, including costs of redesign and claims of other contractors affected by any resulting change.
- B. *Substitute Construction Methods or Procedures:* If a specific means, method, technique, sequence, or procedure of construction is expressly required by the Contract Documents, Contractor may furnish or utilize a substitute means, method, technique, sequence, or procedure of construction approved by Engineer. Contractor shall submit sufficient information to allow Engineer, in Engineer's sole discretion, to determine that the substitute proposed is equivalent to that expressly called for by the Contract Documents. The requirements for review by Engineer will be similar to those provided in Paragraph 6.05.A.2.
- C. *Engineer's Evaluation:* Engineer will be allowed a reasonable time within which to evaluate each proposal or submittal made pursuant to Paragraphs 6.05.A and 6.05.B. Engineer may require Contractor to furnish additional data about the proposed substitute item. Engineer will be the sole judge of acceptability. No "or equal" or substitute will be ordered, installed or utilized until Engineer's review is complete, which will be evidenced by a Change Order in the case of a substitute and an approved Shop Drawing for an "or equal." Engineer will advise Contractor in writing of any negative determination.
- D. *Special Guarantee:* Owner may require Contractor to furnish at Contractor's expense a special performance guarantee or other surety with respect to any substitute.
- E. *Engineer's Cost Reimbursement:* Engineer will record Engineer's costs in evaluating a substitute proposed or submitted by Contractor pursuant to Paragraphs 6.05.A.2 and 6.05.B. Whether or not Engineer approves a substitute so proposed or submitted by Contractor, Contractor shall reimburse Owner for the reasonable charges of Engineer for evaluating each such proposed substitute. Contractor shall also reimburse Owner for the reasonable charges of Engineer for making changes in the Contract Documents (or in the provisions of any other direct contract with Owner) resulting from the acceptance of each proposed substitute.
- F. *Contractor's Expense:* Contractor shall provide all data in support of any proposed substitute or "or-equal" at Contractor's expense.

6.06 *Concerning Subcontractors, Suppliers, and Others*

- A. Contractor shall not employ any Subcontractor, Supplier, or other individual or entity (including those acceptable to Owner as indicated in Paragraph 6.06.B), whether initially or as a replacement, against whom Owner may have reasonable objection. Contractor shall not be required to employ any Subcontractor, Supplier, or other individual or entity to furnish or perform any of the Work against whom Contractor has reasonable objection.
- B. If the Supplementary Conditions require the identity of certain Subcontractors, Suppliers, or other individuals or entities to be submitted to Owner in advance for acceptance by Owner by a specified date prior to the Effective Date of the Agreement, and if Contractor has submitted a list thereof in accordance with the Supplementary Conditions, Owner's acceptance (either in writing or by failing to make written objection thereto by the date indicated for acceptance or objection in the Bidding Documents or the Contract Documents) of any such Subcontractor, Supplier, or

other individual or entity so identified may be revoked on the basis of reasonable objection after due investigation. Contractor shall submit an acceptable replacement for the rejected Subcontractor, Supplier, or other individual or entity, and the Contract Price will be adjusted by the difference in the cost occasioned by such replacement, and an appropriate Change Order will be issued. No acceptance by Owner of any such Subcontractor, Supplier, or other individual or entity, whether initially or as a replacement, shall constitute a waiver of any right of Owner or Engineer to reject defective Work.

- C. Contractor shall be fully responsible to Owner and Engineer for all acts and omissions of the Subcontractors, Suppliers, and other individuals or entities performing or furnishing any of the Work just as Contractor is responsible for Contractor's own acts and omissions. Nothing in the Contract Documents:
1. shall create for the benefit of any such Subcontractor, Supplier, or other individual or entity any contractual relationship between Owner or Engineer and any such Subcontractor, Supplier or other individual or entity; nor
 2. shall create any obligation on the part of Owner or Engineer to pay or to see to the payment of any moneys due any such Subcontractor, Supplier, or other individual or entity except as may otherwise be required by Laws and Regulations.
- D. Contractor shall be solely responsible for scheduling and coordinating the Work of Subcontractors, Suppliers, and other individuals or entities performing or furnishing any of the Work under a direct or indirect contract with Contractor.
- E. Contractor shall require all Subcontractors, Suppliers, and such other individuals or entities performing or furnishing any of the Work to communicate with Engineer through Contractor.
- F. The divisions and sections of the Specifications and the identifications of any Drawings shall not control Contractor in dividing the Work among Subcontractors or Suppliers or delineating the Work to be performed by any specific trade.
- G. All Work performed for Contractor by a Subcontractor or Supplier will be pursuant to an appropriate agreement between Contractor and the Subcontractor or Supplier which specifically binds the Subcontractor or Supplier to the applicable terms and conditions of the Contract Documents for the benefit of Owner and Engineer. Whenever any such agreement is with a Subcontractor or Supplier who is listed as a loss payee on the property insurance provided in Paragraph 5.06, the agreement between the Contractor and the Subcontractor or Supplier will contain provisions whereby the Subcontractor or Supplier waives all rights against Owner, Contractor, Engineer, and all other individuals or entities identified in the Supplementary Conditions to be listed as insureds or loss payees (and the officers, directors, members, partners, employees, agents, consultants, and subcontractors of each and any of them) for all losses and damages caused by, arising out of, relating to, or resulting from any of the perils or causes of loss covered by such policies and any other property insurance applicable to the Work. If the insurers on any such policies require separate waiver forms to be signed by any Subcontractor or Supplier, Contractor will obtain the same.

6.07 *Patent Fees and Royalties*

- A. Contractor shall pay all license fees and royalties and assume all costs incident to the use in the performance of the Work or the incorporation in the Work of any invention, design, process, product, or device which is the subject of patent rights or copyrights held by others. If a particular invention, design, process, product, or device is specified in the Contract Documents for use in the performance of the Work and if, to the actual knowledge of Owner or Engineer, its use is subject to patent rights or copyrights calling for the payment of any license fee or royalty to others, the existence of such rights shall be disclosed by Owner in the Contract Documents.
- B. To the fullest extent permitted by Laws and Regulations, Owner shall indemnify and hold harmless Contractor, and its officers, directors, members, partners, employees, agents, consultants, and subcontractors from and against all claims, costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals, and all court or arbitration or other dispute resolution costs) arising out of or relating to any infringement of patent rights or copyrights incident to the use in the performance of the Work or resulting from the incorporation in the Work of any invention, design, process, product, or device specified in the Contract Documents, but not identified as being subject to payment of any license fee or royalty to others required by patent rights or copyrights.
- C. To the fullest extent permitted by Laws and Regulations, Contractor shall indemnify and hold harmless Owner and Engineer, and the officers, directors, members, partners, employees, agents, consultants and subcontractors of each and any of them from and against all claims, costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) arising out of or relating to any infringement of patent rights or copyrights incident to the use in the performance of the Work or resulting from the incorporation in the Work of any invention, design, process, product, or device not specified in the Contract Documents.

6.08 *Permits*

- A. Unless otherwise provided in the Supplementary Conditions, Contractor shall obtain and pay for all construction permits and licenses. Owner shall assist Contractor, when necessary, in obtaining such permits and licenses. Contractor shall pay all governmental charges and inspection fees necessary for the prosecution of the Work which are applicable at the time of opening of Bids, or, if there are no Bids, on the Effective Date of the Agreement. Owner shall pay all charges of utility owners for connections for providing permanent service to the Work.

6.09 *Laws and Regulations*

- A. Contractor shall give all notices required by and shall comply with all Laws and Regulations applicable to the performance of the Work. Except where otherwise expressly required by applicable Laws and Regulations, neither Owner nor Engineer shall be responsible for monitoring Contractor's compliance with any Laws or Regulations.
- B. If Contractor performs any Work knowing or having reason to know that it is contrary to Laws or Regulations, Contractor shall bear all claims, costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all

court or arbitration or other dispute resolution costs) arising out of or relating to such Work. However, it shall not be Contractor's responsibility to make certain that the Specifications and Drawings are in accordance with Laws and Regulations, but this shall not relieve Contractor of Contractor's obligations under Paragraph 3.03.

- C. Changes in Laws or Regulations not known at the time of opening of Bids (or, on the Effective Date of the Agreement if there were no Bids) having an effect on the cost or time of performance of the Work shall be the subject of an adjustment in Contract Price or Contract Times. If Owner and Contractor are unable to agree on entitlement to or on the amount or extent, if any, of any such adjustment, a Claim may be made therefor as provided in Paragraph 10.05.

6.10 *Taxes*

- A. Contractor shall pay all sales, consumer, use, and other similar taxes required to be paid by Contractor in accordance with the Laws and Regulations of the place of the Project which are applicable during the performance of the Work.

6.11 *Use of Site and Other Areas*

A. *Limitation on Use of Site and Other Areas:*

1. Contractor shall confine construction equipment, the storage of materials and equipment, and the operations of workers to the Site and other areas permitted by Laws and Regulations, and shall not unreasonably encumber the Site and other areas with construction equipment or other materials or equipment. Contractor shall assume full responsibility for any damage to any such land or area, or to the owner or occupant thereof, or of any adjacent land or areas resulting from the performance of the Work.
2. Should any claim be made by any such owner or occupant because of the performance of the Work, Contractor shall promptly settle with such other party by negotiation or otherwise resolve the claim by arbitration or other dispute resolution proceeding or at law.
3. To the fullest extent permitted by Laws and Regulations, Contractor shall indemnify and hold harmless Owner and Engineer, and the officers, directors, members, partners, employees, agents, consultants and subcontractors of each and any of them from and against all claims, costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) arising out of or relating to any claim or action, legal or equitable, brought by any such owner or occupant against Owner, Engineer, or any other party indemnified hereunder to the extent caused by or based upon Contractor's performance of the Work.

- B. *Removal of Debris During Performance of the Work:* During the progress of the Work Contractor shall keep the Site and other areas free from accumulations of waste materials, rubbish, and other debris. Removal and disposal of such waste materials, rubbish, and other debris shall conform to applicable Laws and Regulations.

- C. *Cleaning:* Prior to Substantial Completion of the Work Contractor shall clean the Site and the Work and make it ready for utilization by Owner. At the completion of the Work Contractor

shall remove from the Site all tools, appliances, construction equipment and machinery, and surplus materials and shall restore to original condition all property not designated for alteration by the Contract Documents.

- D. *Loading Structures:* Contractor shall not load nor permit any part of any structure to be loaded in any manner that will endanger the structure, nor shall Contractor subject any part of the Work or adjacent property to stresses or pressures that will endanger it.

6.12 *Record Documents*

- A. Contractor shall maintain in a safe place at the Site one record copy of all Drawings, Specifications, Addenda, Change Orders, Work Change Directives, Field Orders, and written interpretations and clarifications in good order and annotated to show changes made during construction. These record documents together with all approved Samples and a counterpart of all approved Shop Drawings will be available to Engineer for reference. Upon completion of the Work, these record documents, Samples, and Shop Drawings will be delivered to Engineer for Owner.

6.13 *Safety and Protection*

- A. Contractor shall be solely responsible for initiating, maintaining and supervising all safety precautions and programs in connection with the Work. Such responsibility does not relieve Subcontractors of their responsibility for the safety of persons or property in the performance of their work, nor for compliance with applicable safety Laws and Regulations. Contractor shall take all necessary precautions for the safety of, and shall provide the necessary protection to prevent damage, injury or loss to:
1. all persons on the Site or who may be affected by the Work;
 2. all the Work and materials and equipment to be incorporated therein, whether in storage on or off the Site; and
 3. other property at the Site or adjacent thereto, including trees, shrubs, lawns, walks, pavements, roadways, structures, utilities, and Underground Facilities not designated for removal, relocation, or replacement in the course of construction.
- B. Contractor shall comply with all applicable Laws and Regulations relating to the safety of persons or property, or to the protection of persons or property from damage, injury, or loss; and shall erect and maintain all necessary safeguards for such safety and protection. Contractor shall notify owners of adjacent property and of Underground Facilities and other utility owners when prosecution of the Work may affect them, and shall cooperate with them in the protection, removal, relocation, and replacement of their property.
- C. Contractor shall comply with the applicable requirements of Owner's safety programs, if any. The Supplementary Conditions identify any Owner's safety programs that are applicable to the Work.

- D. Contractor shall inform Owner and Engineer of the specific requirements of Contractor's safety program with which Owner's and Engineer's employees and representatives must comply while at the Site.
- E. All damage, injury, or loss to any property referred to in Paragraph 6.13.A.2 or 6.13.A.3 caused, directly or indirectly, in whole or in part, by Contractor, any Subcontractor, Supplier, or any other individual or entity directly or indirectly employed by any of them to perform any of the Work, or anyone for whose acts any of them may be liable, shall be remedied by Contractor (except damage or loss attributable to the fault of Drawings or Specifications or to the acts or omissions of Owner or Engineer or anyone employed by any of them, or anyone for whose acts any of them may be liable, and not attributable, directly or indirectly, in whole or in part, to the fault or negligence of Contractor or any Subcontractor, Supplier, or other individual or entity directly or indirectly employed by any of them).
- F. Contractor's duties and responsibilities for safety and for protection of the Work shall continue until such time as all the Work is completed and Engineer has issued a notice to Owner and Contractor in accordance with Paragraph 14.07.B that the Work is acceptable (except as otherwise expressly provided in connection with Substantial Completion).

6.14 *Safety Representative*

- A. Contractor shall designate a qualified and experienced safety representative at the Site whose duties and responsibilities shall be the prevention of accidents and the maintaining and supervising of safety precautions and programs.

6.15 *Hazard Communication Programs*

- A. Contractor shall be responsible for coordinating any exchange of material safety data sheets or other hazard communication information required to be made available to or exchanged between or among employers at the Site in accordance with Laws or Regulations.

6.16 *Emergencies*

- A. In emergencies affecting the safety or protection of persons or the Work or property at the Site or adjacent thereto, Contractor is obligated to act to prevent threatened damage, injury, or loss. Contractor shall give Engineer prompt written notice if Contractor believes that any significant changes in the Work or variations from the Contract Documents have been caused thereby or are required as a result thereof. If Engineer determines that a change in the Contract Documents is required because of the action taken by Contractor in response to such an emergency, a Work Change Directive or Change Order will be issued.

6.17 *Shop Drawings and Samples*

- A. Contractor shall submit Shop Drawings and Samples to Engineer for review and approval in accordance with the accepted Schedule of Submittals (as required by Paragraph 2.07). Each submittal will be identified as Engineer may require.

1. *Shop Drawings:*
 - a. Submit number of copies specified in the General Requirements.
 - b. Data shown on the Shop Drawings will be complete with respect to quantities, dimensions, specified performance and design criteria, materials, and similar data to show Engineer the services, materials, and equipment Contractor proposes to provide and to enable Engineer to review the information for the limited purposes required by Paragraph 6.17.D.
 2. *Samples:*
 - a. Submit number of Samples specified in the Specifications.
 - b. Clearly identify each Sample as to material, Supplier, pertinent data such as catalog numbers, the use for which intended and other data as Engineer may require to enable Engineer to review the submittal for the limited purposes required by Paragraph 6.17.D.
- B. Where a Shop Drawing or Sample is required by the Contract Documents or the Schedule of Submittals, any related Work performed prior to Engineer's review and approval of the pertinent submittal will be at the sole expense and responsibility of Contractor.
- C. *Submittal Procedures:*
1. Before submitting each Shop Drawing or Sample, Contractor shall have:
 - a. reviewed and coordinated each Shop Drawing or Sample with other Shop Drawings and Samples and with the requirements of the Work and the Contract Documents;
 - b. determined and verified all field measurements, quantities, dimensions, specified performance and design criteria, installation requirements, materials, catalog numbers, and similar information with respect thereto;
 - c. determined and verified the suitability of all materials offered with respect to the indicated application, fabrication, shipping, handling, storage, assembly, and installation pertaining to the performance of the Work; and
 - d. determined and verified all information relative to Contractor's responsibilities for means, methods, techniques, sequences, and procedures of construction, and safety precautions and programs incident thereto.
 2. Each submittal shall bear a stamp or specific written certification that Contractor has satisfied Contractor's obligations under the Contract Documents with respect to Contractor's review and approval of that submittal.
 3. With each submittal, Contractor shall give Engineer specific written notice of any variations that the Shop Drawing or Sample may have from the requirements of the Contract Documents. This notice shall be both a written communication separate from the Shop

Drawings or Sample submittal; and, in addition, by a specific notation made on each Shop Drawing or Sample submitted to Engineer for review and approval of each such variation.

D. *Engineer's Review:*

1. Engineer will provide timely review of Shop Drawings and Samples in accordance with the Schedule of Submittals acceptable to Engineer. Engineer's review and approval will be only to determine if the items covered by the submittals will, after installation or incorporation in the Work, conform to the information given in the Contract Documents and be compatible with the design concept of the completed Project as a functioning whole as indicated by the Contract Documents.
2. Engineer's review and approval will not extend to means, methods, techniques, sequences, or procedures of construction (except where a particular means, method, technique, sequence, or procedure of construction is specifically and expressly called for by the Contract Documents) or to safety precautions or programs incident thereto. The review and approval of a separate item as such will not indicate approval of the assembly in which the item functions.
3. Engineer's review and approval shall not relieve Contractor from responsibility for any variation from the requirements of the Contract Documents unless Contractor has complied with the requirements of Paragraph 6.17.C.3 and Engineer has given written approval of each such variation by specific written notation thereof incorporated in or accompanying the Shop Drawing or Sample. Engineer's review and approval shall not relieve Contractor from responsibility for complying with the requirements of Paragraph 6.17.C.1.

E. *Resubmittal Procedures:*

1. Contractor shall make corrections required by Engineer and shall return the required number of corrected copies of Shop Drawings and submit, as required, new Samples for review and approval. Contractor shall direct specific attention in writing to revisions other than the corrections called for by Engineer on previous submittals.

6.18 *Continuing the Work*

- A. Contractor shall carry on the Work and adhere to the Progress Schedule during all disputes or disagreements with Owner. No Work shall be delayed or postponed pending resolution of any disputes or disagreements, except as permitted by Paragraph 15.04 or as Owner and Contractor may otherwise agree in writing.

6.19 *Contractor's General Warranty and Guarantee*

- A. Contractor warrants and guarantees to Owner that all Work will be in accordance with the Contract Documents and will not be defective. Engineer and its officers, directors, members, partners, employees, agents, consultants, and subcontractors shall be entitled to rely on representation of Contractor's warranty and guarantee.
- B. Contractor's warranty and guarantee hereunder excludes defects or damage caused by:

1. abuse, modification, or improper maintenance or operation by persons other than Contractor, Subcontractors, Suppliers, or any other individual or entity for whom Contractor is responsible; or
 2. normal wear and tear under normal usage.
- C. Contractor's obligation to perform and complete the Work in accordance with the Contract Documents shall be absolute. None of the following will constitute an acceptance of Work that is not in accordance with the Contract Documents or a release of Contractor's obligation to perform the Work in accordance with the Contract Documents:
1. observations by Engineer;
 2. recommendation by Engineer or payment by Owner of any progress or final payment;
 3. the issuance of a certificate of Substantial Completion by Engineer or any payment related thereto by Owner;
 4. use or occupancy of the Work or any part thereof by Owner;
 5. any review and approval of a Shop Drawing or Sample submittal or the issuance of a notice of acceptability by Engineer;
 6. any inspection, test, or approval by others; or
 7. any correction of defective Work by Owner.

6.20 *Indemnification*

- A. To the fullest extent permitted by Laws and Regulations, Contractor shall indemnify and hold harmless Owner and Engineer, and the officers, directors, members, partners, employees, agents, consultants and subcontractors of each and any of them from and against all claims, costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) arising out of or relating to the performance of the Work, provided that any such claim, cost, loss, or damage is attributable to bodily injury, sickness, disease, or death, or to injury to or destruction of tangible property (other than the Work itself), including the loss of use resulting therefrom but only to the extent caused by any negligent act or omission of Contractor, any Subcontractor, any Supplier, or any individual or entity directly or indirectly employed by any of them to perform any of the Work or anyone for whose acts any of them may be liable .
- B. In any and all claims against Owner or Engineer or any of their officers, directors, members, partners, employees, agents, consultants, or subcontractors by any employee (or the survivor or personal representative of such employee) of Contractor, any Subcontractor, any Supplier, or any individual or entity directly or indirectly employed by any of them to perform any of the Work, or anyone for whose acts any of them may be liable, the indemnification obligation under Paragraph 6.20.A shall not be limited in any way by any limitation on the amount or type of damages, compensation, or benefits payable by or for Contractor or any such Subcontractor,

Supplier, or other individual or entity under workers' compensation acts, disability benefit acts, or other employee benefit acts.

- C. The indemnification obligations of Contractor under Paragraph 6.20.A shall not extend to the liability of Engineer and Engineer's officers, directors, members, partners, employees, agents, consultants and subcontractors arising out of:
 - 1. the preparation or approval of, or the failure to prepare or approve maps, Drawings, opinions, reports, surveys, Change Orders, designs, or Specifications; or
 - 2. giving directions or instructions, or failing to give them, if that is the primary cause of the injury or damage.

6.21 *Delegation of Professional Design Services*

- A. Contractor will not be required to provide professional design services unless such services are specifically required by the Contract Documents for a portion of the Work or unless such services are required to carry out Contractor's responsibilities for construction means, methods, techniques, sequences and procedures. Contractor shall not be required to provide professional services in violation of applicable law.
- B. If professional design services or certifications by a design professional related to systems, materials or equipment are specifically required of Contractor by the Contract Documents, Owner and Engineer will specify all performance and design criteria that such services must satisfy. Contractor shall cause such services or certifications to be provided by a properly licensed professional, whose signature and seal shall appear on all drawings, calculations, specifications, certifications, Shop Drawings and other submittals prepared by such professional. Shop Drawings and other submittals related to the Work designed or certified by such professional, if prepared by others, shall bear such professional's written approval when submitted to Engineer.
- C. Owner and Engineer shall be entitled to rely upon the adequacy, accuracy and completeness of the services, certifications or approvals performed by such design professionals, provided Owner and Engineer have specified to Contractor all performance and design criteria that such services must satisfy.
- D. Pursuant to this Paragraph 6.21, Engineer's review and approval of design calculations and design drawings will be only for the limited purpose of checking for conformance with performance and design criteria given and the design concept expressed in the Contract Documents. Engineer's review and approval of Shop Drawings and other submittals (except design calculations and design drawings) will be only for the purpose stated in Paragraph 6.17.D.1.
- E. Contractor shall not be responsible for the adequacy of the performance or design criteria required by the Contract Documents.

ARTICLE 7 – OTHER WORK AT THE SITE

7.01 *Related Work at Site*

- A. Owner may perform other work related to the Project at the Site with Owner's employees, or through other direct contracts therefor, or have other work performed by utility owners. If such other work is not noted in the Contract Documents, then:
1. written notice thereof will be given to Contractor prior to starting any such other work; and
 2. if Owner and Contractor are unable to agree on entitlement to or on the amount or extent, if any, of any adjustment in the Contract Price or Contract Times that should be allowed as a result of such other work, a Claim may be made therefor as provided in Paragraph 10.05.
- B. Contractor shall afford each other contractor who is a party to such a direct contract, each utility owner, and Owner, if Owner is performing other work with Owner's employees, proper and safe access to the Site, provide a reasonable opportunity for the introduction and storage of materials and equipment and the execution of such other work, and properly coordinate the Work with theirs. Contractor shall do all cutting, fitting, and patching of the Work that may be required to properly connect or otherwise make its several parts come together and properly integrate with such other work. Contractor shall not endanger any work of others by cutting, excavating, or otherwise altering such work; provided, however, that Contractor may cut or alter others' work with the written consent of Engineer and the others whose work will be affected. The duties and responsibilities of Contractor under this Paragraph are for the benefit of such utility owners and other contractors to the extent that there are comparable provisions for the benefit of Contractor in said direct contracts between Owner and such utility owners and other contractors.
- C. If the proper execution or results of any part of Contractor's Work depends upon work performed by others under this Article 7, Contractor shall inspect such other work and promptly report to Engineer in writing any delays, defects, or deficiencies in such other work that render it unavailable or unsuitable for the proper execution and results of Contractor's Work. Contractor's failure to so report will constitute an acceptance of such other work as fit and proper for integration with Contractor's Work except for latent defects and deficiencies in such other work.

7.02 *Coordination*

- A. If Owner intends to contract with others for the performance of other work on the Project at the Site, the following will be set forth in Supplementary Conditions:
1. the individual or entity who will have authority and responsibility for coordination of the activities among the various contractors will be identified;
 2. the specific matters to be covered by such authority and responsibility will be itemized; and
 3. the extent of such authority and responsibilities will be provided.
- B. Unless otherwise provided in the Supplementary Conditions, Owner shall have sole authority and responsibility for such coordination.

7.03 *Legal Relationships*

- A. Paragraphs 7.01.A and 7.02 are not applicable for utilities not under the control of Owner.
- B. Each other direct contract of Owner under Paragraph 7.01.A shall provide that the other contractor is liable to Owner and Contractor for the reasonable direct delay and disruption costs incurred by Contractor as a result of the other contractor's wrongful actions or inactions.
- C. Contractor shall be liable to Owner and any other contractor under direct contract to Owner for the reasonable direct delay and disruption costs incurred by such other contractor as a result of Contractor's wrongful action or inactions.

ARTICLE 8 – OWNER'S RESPONSIBILITIES

8.01 *Communications to Contractor*

- A. Except as otherwise provided in these General Conditions, Owner shall issue all communications to Contractor through Engineer.

8.02 *Replacement of Engineer*

- A. In case of termination of the employment of Engineer, Owner shall appoint an engineer to whom Contractor makes no reasonable objection, whose status under the Contract Documents shall be that of the former Engineer.

8.03 *Furnish Data*

- A. Owner shall promptly furnish the data required of Owner under the Contract Documents.

8.04 *Pay When Due*

- A. Owner shall make payments to Contractor when they are due as provided in Paragraphs 14.02.C and 14.07.C.

8.05 *Lands and Easements; Reports and Tests*

- A. Owner's duties with respect to providing lands and easements and providing engineering surveys to establish reference points are set forth in Paragraphs 4.01 and 4.05. Paragraph 4.02 refers to Owner's identifying and making available to Contractor copies of reports of explorations and tests of subsurface conditions and drawings of physical conditions relating to existing surface or subsurface structures at the Site.

8.06 *Insurance*

- A. Owner's responsibilities, if any, with respect to purchasing and maintaining liability and property insurance are set forth in Article 5.

8.07 *Change Orders*

- A. Owner is obligated to execute Change Orders as indicated in Paragraph 10.03.

8.08 *Inspections, Tests, and Approvals*

- A. Owner's responsibility with respect to certain inspections, tests, and approvals is set forth in Paragraph 13.03.B.

8.09 *Limitations on Owner's Responsibilities*

- A. The Owner shall not supervise, direct, or have control or authority over, nor be responsible for, Contractor's means, methods, techniques, sequences, or procedures of construction, or the safety precautions and programs incident thereto, or for any failure of Contractor to comply with Laws and Regulations applicable to the performance of the Work. Owner will not be responsible for Contractor's failure to perform the Work in accordance with the Contract Documents.

8.10 *Undisclosed Hazardous Environmental Condition*

- A. Owner's responsibility in respect to an undisclosed Hazardous Environmental Condition is set forth in Paragraph 4.06.

8.11 *Evidence of Financial Arrangements*

- A. Upon request of Contractor, Owner shall furnish Contractor reasonable evidence that financial arrangements have been made to satisfy Owner's obligations under the Contract Documents.

8.12 *Compliance with Safety Program*

- A. While at the Site, Owner's employees and representatives shall comply with the specific applicable requirements of Contractor's safety programs of which Owner has been informed pursuant to Paragraph 6.13.D.

ARTICLE 9 – ENGINEER'S STATUS DURING CONSTRUCTION

9.01 *Owner's Representative*

- A. Engineer will be Owner's representative during the construction period. The duties and responsibilities and the limitations of authority of Engineer as Owner's representative during construction are set forth in the Contract Documents.

9.02 *Visits to Site*

- A. Engineer will make visits to the Site at intervals appropriate to the various stages of construction as Engineer deems necessary in order to observe as an experienced and qualified design professional the progress that has been made and the quality of the various aspects of Contractor's executed Work. Based on information obtained during such visits and observations, Engineer, for the benefit of Owner, will determine, in general, if the Work is proceeding in accordance with the Contract Documents. Engineer will not be required to make exhaustive or continuous inspections on the Site to check the quality or quantity of the Work. Engineer's efforts will be directed toward providing for Owner a greater degree of confidence that the completed Work will conform generally to the Contract Documents. On the basis of such visits

and observations, Engineer will keep Owner informed of the progress of the Work and will endeavor to guard Owner against defective Work.

- B. Engineer's visits and observations are subject to all the limitations on Engineer's authority and responsibility set forth in Paragraph 9.09. Particularly, but without limitation, during or as a result of Engineer's visits or observations of Contractor's Work, Engineer will not supervise, direct, control, or have authority over or be responsible for Contractor's means, methods, techniques, sequences, or procedures of construction, or the safety precautions and programs incident thereto, or for any failure of Contractor to comply with Laws and Regulations applicable to the performance of the Work.

9.03 *Project Representative*

- A. If Owner and Engineer agree, Engineer will furnish a Resident Project Representative to assist Engineer in providing more extensive observation of the Work. The authority and responsibilities of any such Resident Project Representative and assistants will be as provided in the Supplementary Conditions, and limitations on the responsibilities thereof will be as provided in Paragraph 9.09. If Owner designates another representative or agent to represent Owner at the Site who is not Engineer's consultant, agent or employee, the responsibilities and authority and limitations thereon of such other individual or entity will be as provided in the Supplementary Conditions.

9.04 *Authorized Variations in Work*

- A. Engineer may authorize minor variations in the Work from the requirements of the Contract Documents which do not involve an adjustment in the Contract Price or the Contract Times and are compatible with the design concept of the completed Project as a functioning whole as indicated by the Contract Documents. These may be accomplished by a Field Order and will be binding on Owner and also on Contractor, who shall perform the Work involved promptly. If Owner or Contractor believes that a Field Order justifies an adjustment in the Contract Price or Contract Times, or both, and the parties are unable to agree on entitlement to or on the amount or extent, if any, of any such adjustment, a Claim may be made therefor as provided in Paragraph 10.05.

9.05 *Rejecting Defective Work*

- A. Engineer will have authority to reject Work which Engineer believes to be defective, or that Engineer believes will not produce a completed Project that conforms to the Contract Documents or that will prejudice the integrity of the design concept of the completed Project as a functioning whole as indicated by the Contract Documents. Engineer will also have authority to require special inspection or testing of the Work as provided in Paragraph 13.04, whether or not the Work is fabricated, installed, or completed.

9.06 *Shop Drawings, Change Orders and Payments*

- A. In connection with Engineer's authority, and limitations thereof, as to Shop Drawings and Samples, see Paragraph 6.17.

- B. In connection with Engineer's authority, and limitations thereof, as to design calculations and design drawings submitted in response to a delegation of professional design services, if any, see Paragraph 6.21.
- C. In connection with Engineer's authority as to Change Orders, see Articles 10, 11, and 12.
- D. In connection with Engineer's authority as to Applications for Payment, see Article 14.

9.07 *Determinations for Unit Price Work*

- A. Engineer will determine the actual quantities and classifications of Unit Price Work performed by Contractor. Engineer will review with Contractor the Engineer's preliminary determinations on such matters before rendering a written decision thereon (by recommendation of an Application for Payment or otherwise). Engineer's written decision thereon will be final and binding (except as modified by Engineer to reflect changed factual conditions or more accurate data) upon Owner and Contractor, subject to the provisions of Paragraph 10.05.

9.08 *Decisions on Requirements of Contract Documents and Acceptability of Work*

- A. Engineer will be the initial interpreter of the requirements of the Contract Documents and judge of the acceptability of the Work thereunder. All matters in question and other matters between Owner and Contractor arising prior to the date final payment is due relating to the acceptability of the Work, and the interpretation of the requirements of the Contract Documents pertaining to the performance of the Work, will be referred initially to Engineer in writing within 30 days of the event giving rise to the question.
- B. Engineer will, with reasonable promptness, render a written decision on the issue referred. If Owner or Contractor believes that any such decision entitles them to an adjustment in the Contract Price or Contract Times or both, a Claim may be made under Paragraph 10.05. The date of Engineer's decision shall be the date of the event giving rise to the issues referenced for the purposes of Paragraph 10.05.B.
- C. Engineer's written decision on the issue referred will be final and binding on Owner and Contractor, subject to the provisions of Paragraph 10.05.
- D. When functioning as interpreter and judge under this Paragraph 9.08, Engineer will not show partiality to Owner or Contractor and will not be liable in connection with any interpretation or decision rendered in good faith in such capacity.

9.09 *Limitations on Engineer's Authority and Responsibilities*

- A. Neither Engineer's authority or responsibility under this Article 9 or under any other provision of the Contract Documents nor any decision made by Engineer in good faith either to exercise or not exercise such authority or responsibility or the undertaking, exercise, or performance of any authority or responsibility by Engineer shall create, impose, or give rise to any duty in contract, tort, or otherwise owed by Engineer to Contractor, any Subcontractor, any Supplier, any other individual or entity, or to any surety for or employee or agent of any of them.

- B. Engineer will not supervise, direct, control, or have authority over or be responsible for Contractor's means, methods, techniques, sequences, or procedures of construction, or the safety precautions and programs incident thereto, or for any failure of Contractor to comply with Laws and Regulations applicable to the performance of the Work. Engineer will not be responsible for Contractor's failure to perform the Work in accordance with the Contract Documents.
- C. Engineer will not be responsible for the acts or omissions of Contractor or of any Subcontractor, any Supplier, or of any other individual or entity performing any of the Work.
- D. Engineer's review of the final Application for Payment and accompanying documentation and all maintenance and operating instructions, schedules, guarantees, bonds, certificates of inspection, tests and approvals, and other documentation required to be delivered by Paragraph 14.07.A will only be to determine generally that their content complies with the requirements of, and in the case of certificates of inspections, tests, and approvals that the results certified indicate compliance with, the Contract Documents.
- E. The limitations upon authority and responsibility set forth in this Paragraph 9.09 shall also apply to the Resident Project Representative, if any, and assistants, if any.

9.10 *Compliance with Safety Program*

- A. While at the Site, Engineer's employees and representatives shall comply with the specific applicable requirements of Contractor's safety programs of which Engineer has been informed pursuant to Paragraph 6.13.D.

ARTICLE 10 – CHANGES IN THE WORK; CLAIMS

10.01 *Authorized Changes in the Work*

- A. Without invalidating the Contract and without notice to any surety, Owner may, at any time or from time to time, order additions, deletions, or revisions in the Work by a Change Order, or a Work Change Directive. Upon receipt of any such document, Contractor shall promptly proceed with the Work involved which will be performed under the applicable conditions of the Contract Documents (except as otherwise specifically provided).
- B. If Owner and Contractor are unable to agree on entitlement to, or on the amount or extent, if any, of an adjustment in the Contract Price or Contract Times, or both, that should be allowed as a result of a Work Change Directive, a Claim may be made therefor as provided in Paragraph 10.05.

10.02 *Unauthorized Changes in the Work*

- A. Contractor shall not be entitled to an increase in the Contract Price or an extension of the Contract Times with respect to any work performed that is not required by the Contract Documents as amended, modified, or supplemented as provided in Paragraph 3.04, except in the case of an emergency as provided in Paragraph 6.16 or in the case of uncovering Work as provided in Paragraph 13.04.D.

10.03 *Execution of Change Orders*

- A. Owner and Contractor shall execute appropriate Change Orders recommended by Engineer covering:
1. changes in the Work which are: (i) ordered by Owner pursuant to Paragraph 10.01.A, (ii) required because of acceptance of defective Work under Paragraph 13.08.A or Owner's correction of defective Work under Paragraph 13.09, or (iii) agreed to by the parties;
 2. changes in the Contract Price or Contract Times which are agreed to by the parties, including any undisputed sum or amount of time for Work actually performed in accordance with a Work Change Directive; and
 3. changes in the Contract Price or Contract Times which embody the substance of any written decision rendered by Engineer pursuant to Paragraph 10.05; provided that, in lieu of executing any such Change Order, an appeal may be taken from any such decision in accordance with the provisions of the Contract Documents and applicable Laws and Regulations, but during any such appeal, Contractor shall carry on the Work and adhere to the Progress Schedule as provided in Paragraph 6.18.A.

10.04 *Notification to Surety*

- A. If the provisions of any bond require notice to be given to a surety of any change affecting the general scope of the Work or the provisions of the Contract Documents (including, but not limited to, Contract Price or Contract Times), the giving of any such notice will be Contractor's responsibility. The amount of each applicable bond will be adjusted to reflect the effect of any such change.

10.05 *Claims*

- A. *Engineer's Decision Required:* All Claims, except those waived pursuant to Paragraph 14.09, shall be referred to the Engineer for decision. A decision by Engineer shall be required as a condition precedent to any exercise by Owner or Contractor of any rights or remedies either may otherwise have under the Contract Documents or by Laws and Regulations in respect of such Claims.
- B. *Notice:* Written notice stating the general nature of each Claim shall be delivered by the claimant to Engineer and the other party to the Contract promptly (but in no event later than 30 days) after the start of the event giving rise thereto. The responsibility to substantiate a Claim shall rest with the party making the Claim. Notice of the amount or extent of the Claim, with supporting data shall be delivered to the Engineer and the other party to the Contract within 60 days after the start of such event (unless Engineer allows additional time for claimant to submit additional or more accurate data in support of such Claim). A Claim for an adjustment in Contract Price shall be prepared in accordance with the provisions of Paragraph 12.01.B. A Claim for an adjustment in Contract Times shall be prepared in accordance with the provisions of Paragraph 12.02.B. Each Claim shall be accompanied by claimant's written statement that the adjustment claimed is the entire adjustment to which the claimant believes it is entitled as a result of said event. The

opposing party shall submit any response to Engineer and the claimant within 30 days after receipt of the claimant's last submittal (unless Engineer allows additional time).

- C. *Engineer's Action:* Engineer will review each Claim and, within 30 days after receipt of the last submittal of the claimant or the last submittal of the opposing party, if any, take one of the following actions in writing:
1. deny the Claim in whole or in part;
 2. approve the Claim; or
 3. notify the parties that the Engineer is unable to resolve the Claim if, in the Engineer's sole discretion, it would be inappropriate for the Engineer to do so. For purposes of further resolution of the Claim, such notice shall be deemed a denial.
- D. In the event that Engineer does not take action on a Claim within said 30 days, the Claim shall be deemed denied.
- E. Engineer's written action under Paragraph 10.05.C or denial pursuant to Paragraphs 10.05.C.3 or 10.05.D will be final and binding upon Owner and Contractor, unless Owner or Contractor invoke the dispute resolution procedure set forth in Article 16 within 30 days of such action or denial.
- F. No Claim for an adjustment in Contract Price or Contract Times will be valid if not submitted in accordance with this Paragraph 10.05.

ARTICLE 11 – COST OF THE WORK; ALLOWANCES; UNIT PRICE WORK

11.01 Cost of the Work

- A. *Costs Included:* The term Cost of the Work means the sum of all costs, except those excluded in Paragraph 11.01.B, necessarily incurred and paid by Contractor in the proper performance of the Work. When the value of any Work covered by a Change Order or when a Claim for an adjustment in Contract Price is determined on the basis of Cost of the Work, the costs to be reimbursed to Contractor will be only those additional or incremental costs required because of the change in the Work or because of the event giving rise to the Claim. Except as otherwise may be agreed to in writing by Owner, such costs shall be in amounts no higher than those prevailing in the locality of the Project, shall not include any of the costs itemized in Paragraph 11.01.B, and shall include only the following items:
1. Payroll costs for employees in the direct employ of Contractor in the performance of the Work under schedules of job classifications agreed upon by Owner and Contractor. Such employees shall include, without limitation, superintendents, foremen, and other personnel employed full time on the Work. Payroll costs for employees not employed full time on the Work shall be apportioned on the basis of their time spent on the Work. Payroll costs shall include, but not be limited to, salaries and wages plus the cost of fringe benefits, which shall include social security contributions, unemployment, excise, and payroll taxes, workers' compensation, health and retirement benefits, bonuses, sick leave, vacation and holiday pay applicable thereto. The expenses of performing Work outside of regular working hours, on

Saturday, Sunday, or legal holidays, shall be included in the above to the extent authorized by Owner.

2. Cost of all materials and equipment furnished and incorporated in the Work, including costs of transportation and storage thereof, and Suppliers' field services required in connection therewith. All cash discounts shall accrue to Contractor unless Owner deposits funds with Contractor with which to make payments, in which case the cash discounts shall accrue to Owner. All trade discounts, rebates and refunds and returns from sale of surplus materials and equipment shall accrue to Owner, and Contractor shall make provisions so that they may be obtained.
3. Payments made by Contractor to Subcontractors for Work performed by Subcontractors. If required by Owner, Contractor shall obtain competitive bids from subcontractors acceptable to Owner and Contractor and shall deliver such bids to Owner, who will then determine, with the advice of Engineer, which bids, if any, will be acceptable. If any subcontract provides that the Subcontractor is to be paid on the basis of Cost of the Work plus a fee, the Subcontractor's Cost of the Work and fee shall be determined in the same manner as Contractor's Cost of the Work and fee as provided in this Paragraph 11.01.
4. Costs of special consultants (including but not limited to engineers, architects, testing laboratories, surveyors, attorneys, and accountants) employed for services specifically related to the Work.
5. Supplemental costs including the following:
 - a. The proportion of necessary transportation, travel, and subsistence expenses of Contractor's employees incurred in discharge of duties connected with the Work.
 - b. Cost, including transportation and maintenance, of all materials, supplies, equipment, machinery, appliances, office, and temporary facilities at the Site, and hand tools not owned by the workers, which are consumed in the performance of the Work, and cost, less market value, of such items used but not consumed which remain the property of Contractor.
 - c. Rentals of all construction equipment and machinery, and the parts thereof whether rented from Contractor or others in accordance with rental agreements approved by Owner with the advice of Engineer, and the costs of transportation, loading, unloading, assembly, dismantling, and removal thereof. All such costs shall be in accordance with the terms of said rental agreements. The rental of any such equipment, machinery, or parts shall cease when the use thereof is no longer necessary for the Work.
 - d. Sales, consumer, use, and other similar taxes related to the Work, and for which Contractor is liable, as imposed by Laws and Regulations.
 - e. Deposits lost for causes other than negligence of Contractor, any Subcontractor, or anyone directly or indirectly employed by any of them or for whose acts any of them may be liable, and royalty payments and fees for permits and licenses.

- f. Losses and damages (and related expenses) caused by damage to the Work, not compensated by insurance or otherwise, sustained by Contractor in connection with the performance of the Work (except losses and damages within the deductible amounts of property insurance established in accordance with Paragraph 5.06.D), provided such losses and damages have resulted from causes other than the negligence of Contractor, any Subcontractor, or anyone directly or indirectly employed by any of them or for whose acts any of them may be liable. Such losses shall include settlements made with the written consent and approval of Owner. No such losses, damages, and expenses shall be included in the Cost of the Work for the purpose of determining Contractor's fee.
- g. The cost of utilities, fuel, and sanitary facilities at the Site.
- h. Minor expenses such as telegrams, long distance telephone calls, telephone service at the Site, express and courier services, and similar petty cash items in connection with the Work.
- i. The costs of premiums for all bonds and insurance Contractor is required by the Contract Documents to purchase and maintain.

B. *Costs Excluded:* The term Cost of the Work shall not include any of the following items:

- 1. Payroll costs and other compensation of Contractor's officers, executives, principals (of partnerships and sole proprietorships), general managers, safety managers, engineers, architects, estimators, attorneys, auditors, accountants, purchasing and contracting agents, expeditors, timekeepers, clerks, and other personnel employed by Contractor, whether at the Site or in Contractor's principal or branch office for general administration of the Work and not specifically included in the agreed upon schedule of job classifications referred to in Paragraph 11.01.A.1 or specifically covered by Paragraph 11.01.A.4, all of which are to be considered administrative costs covered by the Contractor's fee.
- 2. Expenses of Contractor's principal and branch offices other than Contractor's office at the Site.
- 3. Any part of Contractor's capital expenses, including interest on Contractor's capital employed for the Work and charges against Contractor for delinquent payments.
- 4. Costs due to the negligence of Contractor, any Subcontractor, or anyone directly or indirectly employed by any of them or for whose acts any of them may be liable, including but not limited to, the correction of defective Work, disposal of materials or equipment wrongly supplied, and making good any damage to property.
- 5. Other overhead or general expense costs of any kind and the costs of any item not specifically and expressly included in Paragraphs 11.01.A.

C. *Contractor's Fee:* When all the Work is performed on the basis of cost-plus, Contractor's fee shall be determined as set forth in the Agreement. When the value of any Work covered by a Change Order or when a Claim for an adjustment in Contract Price is determined on the basis of Cost of the Work, Contractor's fee shall be determined as set forth in Paragraph 12.01.C.

- D. *Documentation:* Whenever the Cost of the Work for any purpose is to be determined pursuant to Paragraphs 11.01.A and 11.01.B, Contractor will establish and maintain records thereof in accordance with generally accepted accounting practices and submit in a form acceptable to Engineer an itemized cost breakdown together with supporting data.

11.02 *Allowances*

- A. It is understood that Contractor has included in the Contract Price all allowances so named in the Contract Documents and shall cause the Work so covered to be performed for such sums and by such persons or entities as may be acceptable to Owner and Engineer.
- B. *Cash Allowances:*
1. Contractor agrees that:
 - a. the cash allowances include the cost to Contractor (less any applicable trade discounts) of materials and equipment required by the allowances to be delivered at the Site, and all applicable taxes; and
 - b. Contractor's costs for unloading and handling on the Site, labor, installation, overhead, profit, and other expenses contemplated for the cash allowances have been included in the Contract Price and not in the allowances, and no demand for additional payment on account of any of the foregoing will be valid.
- C. *Contingency Allowance:*
1. Contractor agrees that a contingency allowance, if any, is for the sole use of Owner to cover unanticipated costs.
- D. Prior to final payment, an appropriate Change Order will be issued as recommended by Engineer to reflect actual amounts due Contractor on account of Work covered by allowances, and the Contract Price shall be correspondingly adjusted.

11.03 *Unit Price Work*

- A. Where the Contract Documents provide that all or part of the Work is to be Unit Price Work, initially the Contract Price will be deemed to include for all Unit Price Work an amount equal to the sum of the unit price for each separately identified item of Unit Price Work times the estimated quantity of each item as indicated in the Agreement.
- B. The estimated quantities of items of Unit Price Work are not guaranteed and are solely for the purpose of comparison of Bids and determining an initial Contract Price. Determinations of the actual quantities and classifications of Unit Price Work performed by Contractor will be made by Engineer subject to the provisions of Paragraph 9.07.
- C. Each unit price will be deemed to include an amount considered by Contractor to be adequate to cover Contractor's overhead and profit for each separately identified item.

- D. Owner or Contractor may make a Claim for an adjustment in the Contract Price in accordance with Paragraph 10.05 if:
1. the quantity of any item of Unit Price Work performed by Contractor differs materially and significantly from the estimated quantity of such item indicated in the Agreement; and
 2. there is no corresponding adjustment with respect to any other item of Work; and
 3. Contractor believes that Contractor is entitled to an increase in Contract Price as a result of having incurred additional expense or Owner believes that Owner is entitled to a decrease in Contract Price and the parties are unable to agree as to the amount of any such increase or decrease.

ARTICLE 12 – CHANGE OF CONTRACT PRICE; CHANGE OF CONTRACT TIMES

12.01 Change of Contract Price

- A. The Contract Price may only be changed by a Change Order. Any Claim for an adjustment in the Contract Price shall be based on written notice submitted by the party making the Claim to the Engineer and the other party to the Contract in accordance with the provisions of Paragraph 10.05.
- B. The value of any Work covered by a Change Order or of any Claim for an adjustment in the Contract Price will be determined as follows:
1. where the Work involved is covered by unit prices contained in the Contract Documents, by application of such unit prices to the quantities of the items involved (subject to the provisions of Paragraph 11.03); or
 2. where the Work involved is not covered by unit prices contained in the Contract Documents, by a mutually agreed lump sum (which may include an allowance for overhead and profit not necessarily in accordance with Paragraph 12.01.C.2); or
 3. where the Work involved is not covered by unit prices contained in the Contract Documents and agreement to a lump sum is not reached under Paragraph 12.01.B.2, on the basis of the Cost of the Work (determined as provided in Paragraph 11.01) plus a Contractor's fee for overhead and profit (determined as provided in Paragraph 12.01.C).
- C. *Contractor's Fee:* The Contractor's fee for overhead and profit shall be determined as follows:
1. a mutually acceptable fixed fee; or
 2. if a fixed fee is not agreed upon, then a fee based on the following percentages of the various portions of the Cost of the Work:
 - a. for costs incurred under Paragraphs 11.01.A.1 and 11.01.A.2, the Contractor's fee shall be 15 percent;
 - b. for costs incurred under Paragraph 11.01.A.3, the Contractor's fee shall be five percent;

- c. where one or more tiers of subcontracts are on the basis of Cost of the Work plus a fee and no fixed fee is agreed upon, the intent of Paragraphs 12.01.C.2.a and 12.01.C.2.b is that the Subcontractor who actually performs the Work, at whatever tier, will be paid a fee of 15 percent of the costs incurred by such Subcontractor under Paragraphs 11.01.A.1 and 11.01.A.2 and that any higher tier Subcontractor and Contractor will each be paid a fee of five percent of the amount paid to the next lower tier Subcontractor;
- d. no fee shall be payable on the basis of costs itemized under Paragraphs 11.01.A.4, 11.01.A.5, and 11.01.B;
- e. the amount of credit to be allowed by Contractor to Owner for any change which results in a net decrease in cost will be the amount of the actual net decrease in cost plus a deduction in Contractor's fee by an amount equal to five percent of such net decrease; and
- f. when both additions and credits are involved in any one change, the adjustment in Contractor's fee shall be computed on the basis of the net change in accordance with Paragraphs 12.01.C.2.a through 12.01.C.2.e, inclusive.

12.02 *Change of Contract Times*

- A. The Contract Times may only be changed by a Change Order. Any Claim for an adjustment in the Contract Times shall be based on written notice submitted by the party making the Claim to the Engineer and the other party to the Contract in accordance with the provisions of Paragraph 10.05.
- B. Any adjustment of the Contract Times covered by a Change Order or any Claim for an adjustment in the Contract Times will be determined in accordance with the provisions of this Article 12.

12.03 *Delays*

- A. Where Contractor is prevented from completing any part of the Work within the Contract Times due to delay beyond the control of Contractor, the Contract Times will be extended in an amount equal to the time lost due to such delay if a Claim is made therefor as provided in Paragraph 12.02.A. Delays beyond the control of Contractor shall include, but not be limited to, acts or neglect by Owner, acts or neglect of utility owners or other contractors performing other work as contemplated by Article 7, fires, floods, epidemics, abnormal weather conditions, or acts of God.
- B. If Owner, Engineer, or other contractors or utility owners performing other work for Owner as contemplated by Article 7, or anyone for whom Owner is responsible, delays, disrupts, or interferes with the performance or progress of the Work, then Contractor shall be entitled to an equitable adjustment in the Contract Price or the Contract Times, or both. Contractor's entitlement to an adjustment of the Contract Times is conditioned on such adjustment being essential to Contractor's ability to complete the Work within the Contract Times.
- C. If Contractor is delayed in the performance or progress of the Work by fire, flood, epidemic, abnormal weather conditions, acts of God, acts or failures to act of utility owners not under the

control of Owner, or other causes not the fault of and beyond control of Owner and Contractor, then Contractor shall be entitled to an equitable adjustment in Contract Times, if such adjustment is essential to Contractor's ability to complete the Work within the Contract Times. Such an adjustment shall be Contractor's sole and exclusive remedy for the delays described in this Paragraph 12.03.C.

- D. Owner, Engineer, and their officers, directors, members, partners, employees, agents, consultants, or subcontractors shall not be liable to Contractor for any claims, costs, losses, or damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) sustained by Contractor on or in connection with any other project or anticipated project.
- E. Contractor shall not be entitled to an adjustment in Contract Price or Contract Times for delays within the control of Contractor. Delays attributable to and within the control of a Subcontractor or Supplier shall be deemed to be delays within the control of Contractor.

ARTICLE 13 – TESTS AND INSPECTIONS; CORRECTION, REMOVAL OR ACCEPTANCE OF DEFECTIVE WORK

13.01 Notice of Defects

- A. Prompt notice of all defective Work of which Owner or Engineer has actual knowledge will be given to Contractor. Defective Work may be rejected, corrected, or accepted as provided in this Article 13.

13.02 Access to Work

- A. Owner, Engineer, their consultants and other representatives and personnel of Owner, independent testing laboratories, and governmental agencies with jurisdictional interests will have access to the Site and the Work at reasonable times for their observation, inspection, and testing. Contractor shall provide them proper and safe conditions for such access and advise them of Contractor's safety procedures and programs so that they may comply therewith as applicable.

13.03 Tests and Inspections

- A. Contractor shall give Engineer timely notice of readiness of the Work for all required inspections, tests, or approvals and shall cooperate with inspection and testing personnel to facilitate required inspections or tests.
- B. Owner shall employ and pay for the services of an independent testing laboratory to perform all inspections, tests, or approvals required by the Contract Documents except:
 - 1. for inspections, tests, or approvals covered by Paragraphs 13.03.C and 13.03.D below;
 - 2. that costs incurred in connection with tests or inspections conducted pursuant to Paragraph 13.04.B shall be paid as provided in Paragraph 13.04.C; and
 - 3. as otherwise specifically provided in the Contract Documents.

- C. If Laws or Regulations of any public body having jurisdiction require any Work (or part thereof) specifically to be inspected, tested, or approved by an employee or other representative of such public body, Contractor shall assume full responsibility for arranging and obtaining such inspections, tests, or approvals, pay all costs in connection therewith, and furnish Engineer the required certificates of inspection or approval.
- D. Contractor shall be responsible for arranging and obtaining and shall pay all costs in connection with any inspections, tests, or approvals required for Owner's and Engineer's acceptance of materials or equipment to be incorporated in the Work; or acceptance of materials, mix designs, or equipment submitted for approval prior to Contractor's purchase thereof for incorporation in the Work. Such inspections, tests, or approvals shall be performed by organizations acceptable to Owner and Engineer.
- E. If any Work (or the work of others) that is to be inspected, tested, or approved is covered by Contractor without written concurrence of Engineer, Contractor shall, if requested by Engineer, uncover such Work for observation.
- F. Uncovering Work as provided in Paragraph 13.03.E shall be at Contractor's expense unless Contractor has given Engineer timely notice of Contractor's intention to cover the same and Engineer has not acted with reasonable promptness in response to such notice.

13.04 *Uncovering Work*

- A. If any Work is covered contrary to the written request of Engineer, it must, if requested by Engineer, be uncovered for Engineer's observation and replaced at Contractor's expense.
- B. If Engineer considers it necessary or advisable that covered Work be observed by Engineer or inspected or tested by others, Contractor, at Engineer's request, shall uncover, expose, or otherwise make available for observation, inspection, or testing as Engineer may require, that portion of the Work in question, furnishing all necessary labor, material, and equipment.
- C. If it is found that the uncovered Work is defective, Contractor shall pay all claims, costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) arising out of or relating to such uncovering, exposure, observation, inspection, and testing, and of satisfactory replacement or reconstruction (including but not limited to all costs of repair or replacement of work of others); and Owner shall be entitled to an appropriate decrease in the Contract Price. If the parties are unable to agree as to the amount thereof, Owner may make a Claim therefor as provided in Paragraph 10.05.
- D. If the uncovered Work is not found to be defective, Contractor shall be allowed an increase in the Contract Price or an extension of the Contract Times, or both, directly attributable to such uncovering, exposure, observation, inspection, testing, replacement, and reconstruction. If the parties are unable to agree as to the amount or extent thereof, Contractor may make a Claim therefor as provided in Paragraph 10.05.

13.05 *Owner May Stop the Work*

- A. If the Work is defective, or Contractor fails to supply sufficient skilled workers or suitable materials or equipment, or fails to perform the Work in such a way that the completed Work will conform to the Contract Documents, Owner may order Contractor to stop the Work, or any portion thereof, until the cause for such order has been eliminated; however, this right of Owner to stop the Work shall not give rise to any duty on the part of Owner to exercise this right for the benefit of Contractor, any Subcontractor, any Supplier, any other individual or entity, or any surety for, or employee or agent of any of them.

13.06 *Correction or Removal of Defective Work*

- A. Promptly after receipt of written notice, Contractor shall correct all defective Work, whether or not fabricated, installed, or completed, or, if the Work has been rejected by Engineer, remove it from the Project and replace it with Work that is not defective. Contractor shall pay all claims, costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) arising out of or relating to such correction or removal (including but not limited to all costs of repair or replacement of work of others).
- B. When correcting defective Work under the terms of this Paragraph 13.06 or Paragraph 13.07, Contractor shall take no action that would void or otherwise impair Owner's special warranty and guarantee, if any, on said Work.

13.07 *Correction Period*

- A. If within one year after the date of Substantial Completion (or such longer period of time as may be prescribed by the terms of any applicable special guarantee required by the Contract Documents) or by any specific provision of the Contract Documents, any Work is found to be defective, or if the repair of any damages to the land or areas made available for Contractor's use by Owner or permitted by Laws and Regulations as contemplated in Paragraph 6.11.A is found to be defective, Contractor shall promptly, without cost to Owner and in accordance with Owner's written instructions:
 - 1. repair such defective land or areas; or
 - 2. correct such defective Work; or
 - 3. if the defective Work has been rejected by Owner, remove it from the Project and replace it with Work that is not defective, and
 - 4. satisfactorily correct or repair or remove and replace any damage to other Work, to the work of others or other land or areas resulting therefrom.
- B. If Contractor does not promptly comply with the terms of Owner's written instructions, or in an emergency where delay would cause serious risk of loss or damage, Owner may have the defective Work corrected or repaired or may have the rejected Work removed and replaced. All claims, costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute

resolution costs) arising out of or relating to such correction or repair or such removal and replacement (including but not limited to all costs of repair or replacement of work of others) will be paid by Contractor.

- C. In special circumstances where a particular item of equipment is placed in continuous service before Substantial Completion of all the Work, the correction period for that item may start to run from an earlier date if so provided in the Specifications.
- D. Where defective Work (and damage to other Work resulting therefrom) has been corrected or removed and replaced under this Paragraph 13.07, the correction period hereunder with respect to such Work will be extended for an additional period of one year after such correction or removal and replacement has been satisfactorily completed.
- E. Contractor's obligations under this Paragraph 13.07 are in addition to any other obligation or warranty. The provisions of this Paragraph 13.07 shall not be construed as a substitute for, or a waiver of, the provisions of any applicable statute of limitation or repose.

13.08 *Acceptance of Defective Work*

- A. If, instead of requiring correction or removal and replacement of defective Work, Owner (and, prior to Engineer's recommendation of final payment, Engineer) prefers to accept it, Owner may do so. Contractor shall pay all claims, costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) attributable to Owner's evaluation of and determination to accept such defective Work (such costs to be approved by Engineer as to reasonableness) and for the diminished value of the Work to the extent not otherwise paid by Contractor pursuant to this sentence. If any such acceptance occurs prior to Engineer's recommendation of final payment, a Change Order will be issued incorporating the necessary revisions in the Contract Documents with respect to the Work, and Owner shall be entitled to an appropriate decrease in the Contract Price, reflecting the diminished value of Work so accepted. If the parties are unable to agree as to the amount thereof, Owner may make a Claim therefor as provided in Paragraph 10.05. If the acceptance occurs after such recommendation, an appropriate amount will be paid by Contractor to Owner.

13.09 *Owner May Correct Defective Work*

- A. If Contractor fails within a reasonable time after written notice from Engineer to correct defective Work, or to remove and replace rejected Work as required by Engineer in accordance with Paragraph 13.06.A, or if Contractor fails to perform the Work in accordance with the Contract Documents, or if Contractor fails to comply with any other provision of the Contract Documents, Owner may, after seven days written notice to Contractor, correct, or remedy any such deficiency.
- B. In exercising the rights and remedies under this Paragraph 13.09, Owner shall proceed expeditiously. In connection with such corrective or remedial action, Owner may exclude Contractor from all or part of the Site, take possession of all or part of the Work and suspend Contractor's services related thereto, take possession of Contractor's tools, appliances, construction equipment and machinery at the Site, and incorporate in the Work all materials and

equipment stored at the Site or for which Owner has paid Contractor but which are stored elsewhere. Contractor shall allow Owner, Owner's representatives, agents and employees, Owner's other contractors, and Engineer and Engineer's consultants access to the Site to enable Owner to exercise the rights and remedies under this Paragraph.

- C. All claims, costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) incurred or sustained by Owner in exercising the rights and remedies under this Paragraph 13.09 will be charged against Contractor, and a Change Order will be issued incorporating the necessary revisions in the Contract Documents with respect to the Work; and Owner shall be entitled to an appropriate decrease in the Contract Price. If the parties are unable to agree as to the amount of the adjustment, Owner may make a Claim therefor as provided in Paragraph 10.05. Such claims, costs, losses and damages will include but not be limited to all costs of repair, or replacement of work of others destroyed or damaged by correction, removal, or replacement of Contractor's defective Work.
- D. Contractor shall not be allowed an extension of the Contract Times because of any delay in the performance of the Work attributable to the exercise by Owner of Owner's rights and remedies under this Paragraph 13.09.

ARTICLE 14 – PAYMENTS TO CONTRACTOR AND COMPLETION

14.01 Schedule of Values

- A. The Schedule of Values established as provided in Paragraph 2.07.A will serve as the basis for progress payments and will be incorporated into a form of Application for Payment acceptable to Engineer. Progress payments on account of Unit Price Work will be based on the number of units completed.

14.02 Progress Payments

A. Applications for Payments:

1. At least 20 days before the date established in the Agreement for each progress payment (but not more often than once a month), Contractor shall submit to Engineer for review an Application for Payment filled out and signed by Contractor covering the Work completed as of the date of the Application and accompanied by such supporting documentation as is required by the Contract Documents. If payment is requested on the basis of materials and equipment not incorporated in the Work but delivered and suitably stored at the Site or at another location agreed to in writing, the Application for Payment shall also be accompanied by a bill of sale, invoice, or other documentation warranting that Owner has received the materials and equipment free and clear of all Liens and evidence that the materials and equipment are covered by appropriate property insurance or other arrangements to protect Owner's interest therein, all of which must be satisfactory to Owner.
2. Beginning with the second Application for Payment, each Application shall include an affidavit of Contractor stating that all previous progress payments received on account of the

Work have been applied on account to discharge Contractor's legitimate obligations associated with prior Applications for Payment.

3. The amount of retainage with respect to progress payments will be as stipulated in the Agreement.

B. *Review of Applications:*

1. Engineer will, within 10 days after receipt of each Application for Payment, either indicate in writing a recommendation of payment and present the Application to Owner or return the Application to Contractor indicating in writing Engineer's reasons for refusing to recommend payment. In the latter case, Contractor may make the necessary corrections and resubmit the Application.
2. Engineer's recommendation of any payment requested in an Application for Payment will constitute a representation by Engineer to Owner, based on Engineer's observations of the executed Work as an experienced and qualified design professional, and on Engineer's review of the Application for Payment and the accompanying data and schedules, that to the best of Engineer's knowledge, information and belief:
 - a. the Work has progressed to the point indicated;
 - b. the quality of the Work is generally in accordance with the Contract Documents (subject to an evaluation of the Work as a functioning whole prior to or upon Substantial Completion, the results of any subsequent tests called for in the Contract Documents, a final determination of quantities and classifications for Unit Price Work under Paragraph 9.07, and any other qualifications stated in the recommendation); and
 - c. the conditions precedent to Contractor's being entitled to such payment appear to have been fulfilled in so far as it is Engineer's responsibility to observe the Work.
3. By recommending any such payment Engineer will not thereby be deemed to have represented that:
 - a. inspections made to check the quality or the quantity of the Work as it has been performed have been exhaustive, extended to every aspect of the Work in progress, or involved detailed inspections of the Work beyond the responsibilities specifically assigned to Engineer in the Contract Documents; or
 - b. there may not be other matters or issues between the parties that might entitle Contractor to be paid additionally by Owner or entitle Owner to withhold payment to Contractor.
4. Neither Engineer's review of Contractor's Work for the purposes of recommending payments nor Engineer's recommendation of any payment, including final payment, will impose responsibility on Engineer:
 - a. to supervise, direct, or control the Work, or

- b. for the means, methods, techniques, sequences, or procedures of construction, or the safety precautions and programs incident thereto, or
 - c. for Contractor's failure to comply with Laws and Regulations applicable to Contractor's performance of the Work, or
 - d. to make any examination to ascertain how or for what purposes Contractor has used the moneys paid on account of the Contract Price, or
 - e. to determine that title to any of the Work, materials, or equipment has passed to Owner free and clear of any Liens.
5. Engineer may refuse to recommend the whole or any part of any payment if, in Engineer's opinion, it would be incorrect to make the representations to Owner stated in Paragraph 14.02.B.2. Engineer may also refuse to recommend any such payment or, because of subsequently discovered evidence or the results of subsequent inspections or tests, revise or revoke any such payment recommendation previously made, to such extent as may be necessary in Engineer's opinion to protect Owner from loss because:
- a. the Work is defective, or completed Work has been damaged, requiring correction or replacement;
 - b. the Contract Price has been reduced by Change Orders;
 - c. Owner has been required to correct defective Work or complete Work in accordance with Paragraph 13.09; or
 - d. Engineer has actual knowledge of the occurrence of any of the events enumerated in Paragraph 15.02.A.

C. Payment Becomes Due:

- 1. Ten days after presentation of the Application for Payment to Owner with Engineer's recommendation, the amount recommended will (subject to the provisions of Paragraph 14.02.D) become due, and when due will be paid by Owner to Contractor.

D. Reduction in Payment:

- 1. Owner may refuse to make payment of the full amount recommended by Engineer because:
 - a. claims have been made against Owner on account of Contractor's performance or furnishing of the Work;
 - b. Liens have been filed in connection with the Work, except where Contractor has delivered a specific bond satisfactory to Owner to secure the satisfaction and discharge of such Liens;
 - c. there are other items entitling Owner to a set-off against the amount recommended; or

- d. Owner has actual knowledge of the occurrence of any of the events enumerated in Paragraphs 14.02.B.5.a through 14.02.B.5.c or Paragraph 15.02.A.
2. If Owner refuses to make payment of the full amount recommended by Engineer, Owner will give Contractor immediate written notice (with a copy to Engineer) stating the reasons for such action and promptly pay Contractor any amount remaining after deduction of the amount so withheld. Owner shall promptly pay Contractor the amount so withheld, or any adjustment thereto agreed to by Owner and Contractor, when Contractor remedies the reasons for such action.
3. Upon a subsequent determination that Owner's refusal of payment was not justified, the amount wrongfully withheld shall be treated as an amount due as determined by Paragraph 14.02.C.1 and subject to interest as provided in the Agreement.

14.03 *Contractor's Warranty of Title*

- A. Contractor warrants and guarantees that title to all Work, materials, and equipment covered by any Application for Payment, whether incorporated in the Project or not, will pass to Owner no later than the time of payment free and clear of all Liens.

14.04 *Substantial Completion*

- A. When Contractor considers the entire Work ready for its intended use Contractor shall notify Owner and Engineer in writing that the entire Work is substantially complete (except for items specifically listed by Contractor as incomplete) and request that Engineer issue a certificate of Substantial Completion.
- B. Promptly after Contractor's notification, Owner, Contractor, and Engineer shall make an inspection of the Work to determine the status of completion. If Engineer does not consider the Work substantially complete, Engineer will notify Contractor in writing giving the reasons therefor.
- C. If Engineer considers the Work substantially complete, Engineer will deliver to Owner a tentative certificate of Substantial Completion which shall fix the date of Substantial Completion. There shall be attached to the certificate a tentative list of items to be completed or corrected before final payment. Owner shall have seven days after receipt of the tentative certificate during which to make written objection to Engineer as to any provisions of the certificate or attached list. If, after considering such objections, Engineer concludes that the Work is not substantially complete, Engineer will, within 14 days after submission of the tentative certificate to Owner, notify Contractor in writing, stating the reasons therefor. If, after consideration of Owner's objections, Engineer considers the Work substantially complete, Engineer will, within said 14 days, execute and deliver to Owner and Contractor a definitive certificate of Substantial Completion (with a revised tentative list of items to be completed or corrected) reflecting such changes from the tentative certificate as Engineer believes justified after consideration of any objections from Owner.
- D. At the time of delivery of the tentative certificate of Substantial Completion, Engineer will deliver to Owner and Contractor a written recommendation as to division of responsibilities

pending final payment between Owner and Contractor with respect to security, operation, safety, and protection of the Work, maintenance, heat, utilities, insurance, and warranties and guarantees. Unless Owner and Contractor agree otherwise in writing and so inform Engineer in writing prior to Engineer's issuing the definitive certificate of Substantial Completion, Engineer's aforesaid recommendation will be binding on Owner and Contractor until final payment.

- E. Owner shall have the right to exclude Contractor from the Site after the date of Substantial Completion subject to allowing Contractor reasonable access to remove its property and complete or correct items on the tentative list.

14.05 *Partial Utilization*

- A. Prior to Substantial Completion of all the Work, Owner may use or occupy any substantially completed part of the Work which has specifically been identified in the Contract Documents, or which Owner, Engineer, and Contractor agree constitutes a separately functioning and usable part of the Work that can be used by Owner for its intended purpose without significant interference with Contractor's performance of the remainder of the Work, subject to the following conditions:
 1. Owner at any time may request Contractor in writing to permit Owner to use or occupy any such part of the Work which Owner believes to be ready for its intended use and substantially complete. If and when Contractor agrees that such part of the Work is substantially complete, Contractor, Owner, and Engineer will follow the procedures of Paragraph 14.04.A through D for that part of the Work.
 2. Contractor at any time may notify Owner and Engineer in writing that Contractor considers any such part of the Work ready for its intended use and substantially complete and request Engineer to issue a certificate of Substantial Completion for that part of the Work.
 3. Within a reasonable time after either such request, Owner, Contractor, and Engineer shall make an inspection of that part of the Work to determine its status of completion. If Engineer does not consider that part of the Work to be substantially complete, Engineer will notify Owner and Contractor in writing giving the reasons therefor. If Engineer considers that part of the Work to be substantially complete, the provisions of Paragraph 14.04 will apply with respect to certification of Substantial Completion of that part of the Work and the division of responsibility in respect thereof and access thereto.
 4. No use or occupancy or separate operation of part of the Work may occur prior to compliance with the requirements of Paragraph 5.10 regarding property insurance.

14.06 *Final Inspection*

- A. Upon written notice from Contractor that the entire Work or an agreed portion thereof is complete, Engineer will promptly make a final inspection with Owner and Contractor and will notify Contractor in writing of all particulars in which this inspection reveals that the Work is incomplete or defective. Contractor shall immediately take such measures as are necessary to complete such Work or remedy such deficiencies.

14.07 *Final Payment*

A. *Application for Payment:*

1. After Contractor has, in the opinion of Engineer, satisfactorily completed all corrections identified during the final inspection and has delivered, in accordance with the Contract Documents, all maintenance and operating instructions, schedules, guarantees, bonds, certificates or other evidence of insurance, certificates of inspection, marked-up record documents (as provided in Paragraph 6.12), and other documents, Contractor may make application for final payment following the procedure for progress payments.
2. The final Application for Payment shall be accompanied (except as previously delivered) by:
 - a. all documentation called for in the Contract Documents, including but not limited to the evidence of insurance required by Paragraph 5.04.B.6;
 - b. consent of the surety, if any, to final payment;
 - c. a list of all Claims against Owner that Contractor believes are unsettled; and
 - d. complete and legally effective releases or waivers (satisfactory to Owner) of all Lien rights arising out of or Liens filed in connection with the Work.
3. In lieu of the releases or waivers of Liens specified in Paragraph 14.07.A.2 and as approved by Owner, Contractor may furnish receipts or releases in full and an affidavit of Contractor that: (i) the releases and receipts include all labor, services, material, and equipment for which a Lien could be filed; and (ii) all payrolls, material and equipment bills, and other indebtedness connected with the Work for which Owner might in any way be responsible, or which might in any way result in liens or other burdens on Owner's property, have been paid or otherwise satisfied. If any Subcontractor or Supplier fails to furnish such a release or receipt in full, Contractor may furnish a bond or other collateral satisfactory to Owner to indemnify Owner against any Lien.

B. *Engineer's Review of Application and Acceptance:*

1. If, on the basis of Engineer's observation of the Work during construction and final inspection, and Engineer's review of the final Application for Payment and accompanying documentation as required by the Contract Documents, Engineer is satisfied that the Work has been completed and Contractor's other obligations under the Contract Documents have been fulfilled, Engineer will, within ten days after receipt of the final Application for Payment, indicate in writing Engineer's recommendation of payment and present the Application for Payment to Owner for payment. At the same time Engineer will also give written notice to Owner and Contractor that the Work is acceptable subject to the provisions of Paragraph 14.09. Otherwise, Engineer will return the Application for Payment to Contractor, indicating in writing the reasons for refusing to recommend final payment, in which case Contractor shall make the necessary corrections and resubmit the Application for Payment.

C. *Payment Becomes Due:*

1. Thirty days after the presentation to Owner of the Application for Payment and accompanying documentation, the amount recommended by Engineer, less any sum Owner is entitled to set off against Engineer's recommendation, including but not limited to liquidated damages, will become due and will be paid by Owner to Contractor.

14.08 *Final Completion Delayed*

- A. If, through no fault of Contractor, final completion of the Work is significantly delayed, and if Engineer so confirms, Owner shall, upon receipt of Contractor's final Application for Payment (for Work fully completed and accepted) and recommendation of Engineer, and without terminating the Contract, make payment of the balance due for that portion of the Work fully completed and accepted. If the remaining balance to be held by Owner for Work not fully completed or corrected is less than the retainage stipulated in the Agreement, and if bonds have been furnished as required in Paragraph 5.01, the written consent of the surety to the payment of the balance due for that portion of the Work fully completed and accepted shall be submitted by Contractor to Engineer with the Application for such payment. Such payment shall be made under the terms and conditions governing final payment, except that it shall not constitute a waiver of Claims.

14.09 *Waiver of Claims*

- A. The making and acceptance of final payment will constitute:
 1. a waiver of all Claims by Owner against Contractor, except Claims arising from unsettled Liens, from defective Work appearing after final inspection pursuant to Paragraph 14.06, from failure to comply with the Contract Documents or the terms of any special guarantees specified therein, or from Contractor's continuing obligations under the Contract Documents; and
 2. a waiver of all Claims by Contractor against Owner other than those previously made in accordance with the requirements herein and expressly acknowledged by Owner in writing as still unsettled.

ARTICLE 15 – SUSPENSION OF WORK AND TERMINATION

15.01 *Owner May Suspend Work*

- A. At any time and without cause, Owner may suspend the Work or any portion thereof for a period of not more than 90 consecutive days by notice in writing to Contractor and Engineer which will fix the date on which Work will be resumed. Contractor shall resume the Work on the date so fixed. Contractor shall be granted an adjustment in the Contract Price or an extension of the Contract Times, or both, directly attributable to any such suspension if Contractor makes a Claim therefor as provided in Paragraph 10.05.

15.02 *Owner May Terminate for Cause*

- A. The occurrence of any one or more of the following events will justify termination for cause:

1. Contractor's persistent failure to perform the Work in accordance with the Contract Documents (including, but not limited to, failure to supply sufficient skilled workers or suitable materials or equipment or failure to adhere to the Progress Schedule established under Paragraph 2.07 as adjusted from time to time pursuant to Paragraph 6.04);
 2. Contractor's disregard of Laws or Regulations of any public body having jurisdiction;
 3. Contractor's repeated disregard of the authority of Engineer; or
 4. Contractor's violation in any substantial way of any provisions of the Contract Documents.
- B. If one or more of the events identified in Paragraph 15.02.A occur, Owner may, after giving Contractor (and surety) seven days written notice of its intent to terminate the services of Contractor:
1. exclude Contractor from the Site, and take possession of the Work and of all Contractor's tools, appliances, construction equipment, and machinery at the Site, and use the same to the full extent they could be used by Contractor (without liability to Contractor for trespass or conversion);
 2. incorporate in the Work all materials and equipment stored at the Site or for which Owner has paid Contractor but which are stored elsewhere; and
 3. complete the Work as Owner may deem expedient.
- C. If Owner proceeds as provided in Paragraph 15.02.B, Contractor shall not be entitled to receive any further payment until the Work is completed. If the unpaid balance of the Contract Price exceeds all claims, costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) sustained by Owner arising out of or relating to completing the Work, such excess will be paid to Contractor. If such claims, costs, losses, and damages exceed such unpaid balance, Contractor shall pay the difference to Owner. Such claims, costs, losses, and damages incurred by Owner will be reviewed by Engineer as to their reasonableness and, when so approved by Engineer, incorporated in a Change Order. When exercising any rights or remedies under this Paragraph, Owner shall not be required to obtain the lowest price for the Work performed.
- D. Notwithstanding Paragraphs 15.02.B and 15.02.C, Contractor's services will not be terminated if Contractor begins within seven days of receipt of notice of intent to terminate to correct its failure to perform and proceeds diligently to cure such failure within no more than 30 days of receipt of said notice.
- E. Where Contractor's services have been so terminated by Owner, the termination will not affect any rights or remedies of Owner against Contractor then existing or which may thereafter accrue. Any retention or payment of moneys due Contractor by Owner will not release Contractor from liability.

- F. If and to the extent that Contractor has provided a performance bond under the provisions of Paragraph 5.01.A, the termination procedures of that bond shall supersede the provisions of Paragraphs 15.02.B and 15.02.C.

15.03 *Owner May Terminate For Convenience*

- A. Upon seven days written notice to Contractor and Engineer, Owner may, without cause and without prejudice to any other right or remedy of Owner, terminate the Contract. In such case, Contractor shall be paid for (without duplication of any items):
1. completed and acceptable Work executed in accordance with the Contract Documents prior to the effective date of termination, including fair and reasonable sums for overhead and profit on such Work;
 2. expenses sustained prior to the effective date of termination in performing services and furnishing labor, materials, or equipment as required by the Contract Documents in connection with uncompleted Work, plus fair and reasonable sums for overhead and profit on such expenses;
 3. all claims, costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) incurred in settlement of terminated contracts with Subcontractors, Suppliers, and others; and
 4. reasonable expenses directly attributable to termination.
- B. Contractor shall not be paid on account of loss of anticipated profits or revenue or other economic loss arising out of or resulting from such termination.

15.04 *Contractor May Stop Work or Terminate*

- A. If, through no act or fault of Contractor, (i) the Work is suspended for more than 90 consecutive days by Owner or under an order of court or other public authority, or (ii) Engineer fails to act on any Application for Payment within 30 days after it is submitted, or (iii) Owner fails for 30 days to pay Contractor any sum finally determined to be due, then Contractor may, upon seven days written notice to Owner and Engineer, and provided Owner or Engineer do not remedy such suspension or failure within that time, terminate the Contract and recover from Owner payment on the same terms as provided in Paragraph 15.03.
- B. In lieu of terminating the Contract and without prejudice to any other right or remedy, if Engineer has failed to act on an Application for Payment within 30 days after it is submitted, or Owner has failed for 30 days to pay Contractor any sum finally determined to be due, Contractor may, seven days after written notice to Owner and Engineer, stop the Work until payment is made of all such amounts due Contractor, including interest thereon. The provisions of this Paragraph 15.04 are not intended to preclude Contractor from making a Claim under Paragraph 10.05 for an adjustment in Contract Price or Contract Times or otherwise for expenses or damage directly attributable to Contractor's stopping the Work as permitted by this Paragraph.

ARTICLE 16 – DISPUTE RESOLUTION

16.01 *Methods and Procedures*

- A. Either Owner or Contractor may request mediation of any Claim submitted to Engineer for a decision under Paragraph 10.05 before such decision becomes final and binding. The mediation will be governed by the Construction Industry Mediation Rules of the American Arbitration Association in effect as of the Effective Date of the Agreement. The request for mediation shall be submitted in writing to the American Arbitration Association and the other party to the Contract. Timely submission of the request shall stay the effect of Paragraph 10.05.E.
- B. Owner and Contractor shall participate in the mediation process in good faith. The process shall be concluded within 60 days of filing of the request. The date of termination of the mediation shall be determined by application of the mediation rules referenced above.
- C. If the Claim is not resolved by mediation, Engineer’s action under Paragraph 10.05.C or a denial pursuant to Paragraphs 10.05.C.3 or 10.05.D shall become final and binding 30 days after termination of the mediation unless, within that time period, Owner or Contractor:
 - 1. elects in writing to invoke any dispute resolution process provided for in the Supplementary Conditions; or
 - 2. agrees with the other party to submit the Claim to another dispute resolution process; or
 - 3. gives written notice to the other party of the intent to submit the Claim to a court of competent jurisdiction.

ARTICLE 17 – MISCELLANEOUS

17.01 *Giving Notice*

- A. Whenever any provision of the Contract Documents requires the giving of written notice, it will be deemed to have been validly given if:
 - 1. delivered in person to the individual or to a member of the firm or to an officer of the corporation for whom it is intended; or
 - 2. delivered at or sent by registered or certified mail, postage prepaid, to the last business address known to the giver of the notice.

17.02 *Computation of Times*

- A. When any period of time is referred to in the Contract Documents by days, it will be computed to exclude the first and include the last day of such period. If the last day of any such period falls on a Saturday or Sunday or on a day made a legal holiday by the law of the applicable jurisdiction, such day will be omitted from the computation.

17.03 *Cumulative Remedies*

- A. The duties and obligations imposed by these General Conditions and the rights and remedies available hereunder to the parties hereto are in addition to, and are not to be construed in any way as a limitation of, any rights and remedies available to any or all of them which are otherwise imposed or available by Laws or Regulations, by special warranty or guarantee, or by other provisions of the Contract Documents. The provisions of this Paragraph will be as effective as if repeated specifically in the Contract Documents in connection with each particular duty, obligation, right, and remedy to which they apply.

17.04 *Survival of Obligations*

- A. All representations, indemnifications, warranties, and guarantees made in, required by, or given in accordance with the Contract Documents, as well as all continuing obligations indicated in the Contract Documents, will survive final payment, completion, and acceptance of the Work or termination or completion of the Contract or termination of the services of Contractor.

17.05 *Controlling Law*

- A. This Contract is to be governed by the law of the state in which the Project is located.

17.06 *Headings*

- A. Article and paragraph headings are inserted for convenience only and do not constitute parts of these General Conditions.

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SECTION 4
SUPPLEMENTARY CONDITIONS

SUPPLEMENTARY CONDITIONS

These Supplementary Conditions amend or supplement the Standard General Conditions of the Construction Contract (EJCDC C-700, 2007 ed.) and other provisions of the Contract Documents as indicated below. All provisions which are not so amended or supplemented herein or in the Specific Project Requirements remain in full force and effect.

SC-1.01 The terms used in these Supplementary Conditions which are defined in the General Conditions have the meaning assigned to them in the General Conditions.

SC-2.02 Delete paragraph 2.02(A) in its entirety and insert the following in its place:

Owner shall furnish one (1) printed/hard copy of the drawings and Project Manual which shall be an executed contract set and one set in electronic format (.pdf), if requested.

SC-2.03 (A) In the last sentence of 2.03A, change "sixtieth day" to "one hundred eightieth day."

SC-2.03 (B) By submission of a bid, the bidder hereby grants consent that the award and execution period shall be extended from sixty days to one hundred fifty days after the date on which the bids are opened.

SC-4.02(A) Change "Supplementary Conditions" to read "Specific Project Requirements."

SC-4.06(G) Delete paragraph 4.06(G) in its entirety.

SC-5.03(A)(1) The required Certificate of Insurance shall be in a form satisfactory to the Owner (most current version of ACORD 25 or approved equal). If the Contractor fails to procure and maintain any specified and/or required insurance, the Owner shall have the right to procure and maintain the said insurance for and in the name of the Contractor and the Contractor shall pay the cost thereof and shall furnish all necessary information to make effective and maintain such insurance.

SC-5.04(B)(1) Change "Supplementary Conditions" to read "Specific Project Requirements."

SC-5.04(B)(2) The limits of liability for the insurance required by paragraph 5.04(A) of the General Conditions shall provide coverage for not less than the following amounts or greater where required by Laws and Regulations:

All of the limits below may be satisfied with an Umbrella/Excess Liability as needed to increase the Primary Policy to required limits.

5.04(A)(1) and (2) Workers' Compensation, etc., under paragraphs 5.04(A)(1) and 5.04(A)(2) of the General Conditions:

- | | |
|--|-------------|
| (a) State | Statutory |
| (b) Applicable Federal (e.g., Longshoreman's): | Statutory |
| (c) Employer's Liability: | \$1,000,000 |

5.04(A)(3), (4) and (5). Contractor's Liability Insurance under paragraphs 5.04(A)(3) through 5.04(A)(5) of the General Conditions which shall also include completed operations and product liability coverage.

- (a) Bodily Injury and Property Damage, Combined Single Limit (CSL) (Except Products and Completed Operations) Property Damage liability insurance will provide Explosion, Collapse, and Underground coverage where applicable.

Each Occurrence	\$2,000,000
General Aggregate	\$4,000,000

- (b) Products and Completed Operations Aggregate \$1,000,000

Products and Completed Operations to be maintained for two (2) years after final payment and Contractor shall continue to provide evidence of such coverage to the Owner on an annual basis during the aforementioned period.

- (c) Personal and Advertising Injury (Per Person/Organization and per occurrence). \$1,000,000
- (d) Fire Damage \$100,000
- (e) If the General Liability Policy includes a General Aggregate, such policy shall be endorsed to have the General Aggregate Per Project Aggregate Limit.

5.04(A)(6) Automobile Liability - (Owned, Non-Owned, Hired)
Contractor may provide split limits or combined single limit.

- (a) Split Limits:

Bodily Injury,	Each Person:	\$2,000,000
	Each Occurrence	\$2,000,000
Property Damage,	Each Occurrence	\$1,000,000

or

- (b) Combined Single Limit

Bodily Injury and Property Damage,	Each Occurrence	\$2,000,000
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SC-5.04(B)(3) Add the following to the end of the paragraph: “to the extent available in the insurance industry with industry standard exclusions and as allowed under the laws and regulations in the State of Ohio;”

SC-5.04(B)(4) Add the following:

Written notice of cancellation for non-payment of premium shall be at least 10 days.

Add the following section:

SC-5.04(C) Unless otherwise stated in Specific Project Requirements, the Contractor shall purchase and provide an "Owner's and Contractor's Protective Policy" with an immediate Effective Date and the Owner listed as the insured (No additional insureds) for the following limits:

Each Occurrence	\$1,000,000
General Aggregate	\$2,000,000

Add the following section:

SC-5.04(D) Unless otherwise stated in Specific Project Requirements the Contractor shall purchase and maintain during the Contract Time "All Risk Builders' Risk Insurance," and/or "Installation Floater Insurance," and/or "Boiler and Machinery Insurance," and any and all insurance requirements of section GC-5.06 of the General Conditions as applicable for the type of work to be performed upon the Project to the full insurable value thereof for the benefit of the Owner, the Contractor, Subcontractors and Suppliers as their interest may appear. This insurance shall cover the work until final acceptance and final payment by the Owner. This provision shall in no way release the Contractor or Contractor's Surety from obligations under the Contract Documents to fully complete the Project. The original policy(s) shall be filed with the Owner or his designated representative.

SC-5.05 *Owner's Liability Insurance*

See SC-5.04(C) above.

SC-5.06 *Property Insurance*

Unless otherwise stated in Specific Project Requirements, the Contractor, not the Owner, shall purchase and maintain during the Contract Time all property insurance required in section GC-5.06 of the General Conditions and as outlined in SC-5.04(D) above.

Add the following section:

SC-6.02(C) The Contractor shall be responsible for the Owner and/or Engineer's additional inspection and administrative costs for work performed beyond regular working hours as defined in this Section.

SC-6.07(B) Delete paragraph 6.07(B) in its entirety.

SC-6.09 (D) Add the following:

D. The contractor agrees to the requirements of RC 153.59, RC 153.591, and RC 153.60.

Add the following section:

SC-6.10(B) Add the following:

Should the Owner be exempt from Ohio State Sales and Use Taxes on materials and equipment to be incorporated in the Project, the Contractor may obtain a waiver and said taxes shall not be included in the Contract Price.

1. Owner will furnish the required certificates of tax exemption to Contractor for use in the purchase of supplies and materials to be incorporated into the work
2. Owner's exemption to Contractor does not apply to construction tools, machinery, equipment, or other property by or leased by Contractor, or to supplies or materials not incorporated into the work.

The Contractor shall withhold and/or pay all consumer, use, property, employment, income and other taxes in accordance with the laws and regulations of the United States, State of Ohio, Owner and other applicable agencies which are applicable during the performance of the work.

SC-6.17 *Shop Drawings and Samples*

Add the following new paragraphs immediately after paragraph 6.17(E):

- F. Contractor shall furnish required submittals with sufficient information and accuracy in order to obtain required approval of an item with no more than three (3) submittals. Engineer will record Engineer's time for reviewing subsequent materials of shop drawings, samples, or other items requiring approval and Contractor shall reimburse Owner for Engineer's charges for such time.
- G. In the event that Contractor requests a substitution for a previously approved item, Contractor shall reimburse Owner for Engineer's charges for such time unless the need for such substitution is beyond the control of the Contractor.

SC-7.02 Delete Section 7.02 of the General Conditions in its entirety and insert the following:

SC-7.02(A) The General Construction Contractor shall be referred to and defined as the Construction Coordinator.

SC-7.02(B) Duties of the Construction Coordinator include the following:

1. Scheduling and coordinating the work of the Prime Contractors including submission and periodic updating of project schedule.

2. Establishing and administrating the site safety program and procedures for the project.
3. See that permits are applied for and obtained on a timely basis. Advise the Engineer of any problems related to permit approval.
4. Monitoring compliance with Laws and Regulations.
5. Maintain project site for dust, sedimentation, debris, waste, and general site cleanliness.
6. Coordinate location and use of temporary construction facilities including but not limited to sanitary, water, power, telephone, and parking.
7. Coordinate Owner interface for utility tie-ins/shut downs.
8. Monitor shop drawing submittal and coordination of submittal information between Prime Contractors.

- SC-10.01 (A) Add the following:
The Owner may request from the Contractor and the Contractor shall provide within ten days of the request, a quote for all ordered changes in the work or work the Owner may be considering to be ordered. The quote shall be a line item, detailed, itemized breakdown of the work.
- SC-11.01(A) For purposes of "Cost of the Work" delete Section 11.01(A), (B), and (C) of the General Conditions in their entirety and insert ODOT 109.05, in its place.
- SC-13.07(A) In the First sentence of Section 13.07(A) remove "Substantial Completion" and insert "Final Acceptance of the entire project and final payment by the Owner."
- SC-13.07(C) Remove 13.07(C) and replace with the following:

All materials and equipment shall be warranted by the respective material supplier or equipment manufacturer until the end of the Contractor's "correction period" (or longer if specified elsewhere in the contract) regardless of date of initial installation or operation of the material or equipment. The cost of such extended warranties as needed from material suppliers or equipment manufacturers to provide warranty coverage until the end of the "correction period" or other period as specified in the contract shall be the responsibility of the prime contractor and shall be assumed to have been included in his bid.
- SC-14.02(A) (3) Delete Section 14.02(A) (3) of the General Conditions in its entirety and insert the following:

Until the job is 50% complete, the Contractor will be paid 92% of the estimated value of labor and material completed in acceptable form. After the work is 50% complete, no further funds shall be retained and the Contractor shall be paid 100% of the estimated value of the remaining labor and material completed in acceptable

form, provided that the Contractor is making satisfactory progress and there is no specific cause for greater withholding. Upon the Owner's agreement that the project is substantially complete, the Retainage may be reduced to twice the value of the remaining punch list work subject to the recommendation of the Engineer and the approval by the Owner.

Add the following section:

SC-14.02(A) (4)

Payment for stored materials at invoice prices or at the unit price bid for materials, or the lesser value of the two, will be made for accepted nonperishable equipment and materials which are to be incorporated into the work, when accepted, delivered, properly stored, and protected upon the site and verified to the Engineer by a copy of the invoice. For materials and equipment meeting the foregoing conditions, the Owner will pay, when properly included in an approved estimate, 92% of the invoice value of the same. Subsequent to the inclusion of a payment for delivered materials in a progress payment, Contractor shall submit no later than the next payment submission, a partial waiver of lien from each and every supplier for whom delivered materials were paid. If no such waiver is submitted prior to or along with the next payment, the amount of delivered materials paid commensurate with that particular item will be deducted from future payments. No payment for delivered materials shall be made for any items that are scheduled to be incorporated in the work within 30 days of submission of the pay estimate. Delivered materials will not be paid in any given month for a total amount less than \$5,000.00. Payment for delivered materials for such items as pipe backfill and roadway subbase will not be routinely considered.

SC-16.01 Delete Article 16 in its entirety and replace with the following:

10/17

ARTICLE 16 - DISPUTE RESOLUTION AGREEMENT - MEDIATION/ARBITRATION

OWNER and CONTRACTOR hereby agree that Article 16 of the General Conditions to the Agreement between OWNER and CONTRACTOR is amended to include the following agreement of the parties:

- 16.01 All claims, disputes, and other matters in question between OWNER and CONTRACTOR arising out of or relating to the Contract Documents or the breach thereof (except for claims which have been waived by the making or acceptance of final payment as provided by paragraph 14.09) will be decided by arbitration in accordance with the Construction Industry Arbitration Rules of the American Arbitration Association then obtaining, subject to the limitations of this Article 16. This agreement so to arbitrate and any other agreement or consent to arbitrate entered into in accordance herewith as provided in this Article 16 will be specifically enforceable under the prevailing law of any court having jurisdiction.
- 16.02 No demand for arbitration of any claim, dispute, or other matter that is required to be referred to Engineer initially for decision in accordance with paragraph 9.09 will be made until the earlier of (a) the date on which ENGINEER has rendered a written decision or (b) the thirty-first day after the parties have presented their evidence to ENGINEER if a written decision has not been rendered by ENGINEER before that date. No demand for arbitration of any such claim, dispute or other matter will be made later than thirty days after the date on which ENGINEER has rendered a written decision in respect thereof in accordance with paragraph 9.08 and the failure to demand arbitration within said thirty days' period will result in Engineer's decision being final and binding upon OWNER and CONTRACTOR. If ENGINEER renders a decision after arbitration proceedings have been initiated, such decision may be entered as evidence but will not supersede the arbitration proceedings, except where the decision is acceptable to the parties concerned. No demand for arbitration of any written decision of ENGINEER rendered in accordance with paragraph 9.08 will be made later than ten days after the part making such demand has delivered written notice of intention to appeal as provided in paragraph 10.05.
- 16.03 Notice of the demand for arbitration will be filed in writing with the other party to the Agreement and with the American Arbitration Association, and a copy will be sent to ENGINEER for information. The demand for arbitration will be made within the thirty-day or ten-day period specified in paragraph 16.02 as applicable, and in all other cases within a reasonable time after the claim, dispute or other matter in question has arisen, and in no event shall any such demand be made after the date when institution of legal or equitable proceedings based on such claim, dispute or other matter in question would be barred by the applicable statute of limitations.
- 16.04 Except as provided in paragraph 16.05 below, no arbitration arising out of or relating to the Contract Documents shall include by consolidation, joinder or in any other manner any other person or entity (including ENGINEER, ENGINEER's Consultant, and the officers, directors, agents, employees, or consultants of any of them) who is not a party to this contract unless:

- (A) the inclusion of such other person or entity is necessary if complete relief is to be afforded among those who are already parties to the arbitration, and
- (B) such other person or entity is substantially involved in a question of law or fact which is common to those who are already parties to the arbitration and which will arise in such proceedings, and
- (C) the written consent of the other person or entity sought to be included and of OWNER and CONTRACTOR has been obtained for such inclusion, which consent shall make specific references to this paragraph; but no such consent shall constitute consent to arbitration of any dispute not specifically described in such consent or to arbitration with any party not specifically identified in such consent.

16.05 Notwithstanding paragraph 16.04 if a claim, dispute or other matter in question between OWNER and CONTRACTOR involves the Work of a Subcontractor, either OWNER or CONTRACTOR may join such Subcontractor as a party to the arbitration between OWNER and CONTRACTOR herein under. CONTRACTOR shall include in all subcontracts required by paragraph 6.06(G) a specific provision whereby the Subcontractor consents to being joined in an arbitration between OWNER and CONTRACTOR involving the Work and such Subcontractor. Nothing in this paragraph 16.05 nor in the provision of such subcontract consenting to joinder shall create any claim, right or cause of action in favor of Subcontractor and against OWNER, ENGINEER, or ENGINEER's Consultants that does not otherwise exist.

16.06 The award rendered by the arbitration will be final, judgment may be entered upon it in any court having jurisdiction thereof, and it will not be subject to modification or appeal.

16.07 OWNER and CONTRACTOR agree that they shall first submit any and all unsettled claim, counterclaims, disputes and other matters in questions between them arising out of or relating to the Contract Documents or the breach thereof ("disputes"), to mediation by the American Arbitration Association under the Construction Industry Mediation Rules of the American Arbitration Association prior to either of them initiating against the other a demand for arbitration pursuant to paragraphs 16.01 through 16.06, unless delay in initiating arbitration would irrevocably prejudice one of the parties. The respective thirty and ten-day time limits within which to file a demand for arbitration as provided in paragraphs 16.02 and 16.03 above shall be suspended with respect to a dispute submitted to mediation within those same applicable time limits and shall remain suspended until ten days after the termination of the mediation. The mediator of any dispute submitted to mediation under this Agreement shall not serve as arbitrator of such dispute unless otherwise agreed.

END OF SECTION

01/2024

SECTION 5
SPECIFICATIONS

SECTION 011100 - SUMMARY OF WORK

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 1 Specification Sections, apply to this Section.

1.2 LOCATION OF THE PROJECT

- A. The project is located in the Village Sunbury, Delaware County. The project site is at the Village of Sunbury Wastewater Treatment Plant, 127 Middleview Dr, Sunbury, OH 43074.

1.3 RELATED DOCUMENTS

- A. The Contract Documents include the Project Manual and the Drawings.
- B. The Project Manual consists of two (2) volumes of Contract Documents. Volume 1 includes the Legal Notice, Table of Contents, Instructions to Bidders, Forms to be completed with the Bid, Contract Forms, General Conditions, Supplementary Conditions, Specific Project Requirements. Volume 2 consists of the technical specifications, including:
 - 1. Divisions 01 through 09, for material and material installation to be incorporated into the work.
 - 2. Divisions 10 through 12 – Specialties for material, furnishings, and installation to be incorporated into the work.
 - 3. Division 13 – Special Construction, material and installation of the metal building.
 - 4. Division 22 – Plumbing for material, equipment and installation to be incorporated into the work.
 - 5. Division 23 – HVAC, material, methods and installation of the HVAC system.
 - 6. Division 26 – Electrical for material, equipment and installation to be incorporated into the work.
 - 7. Division 31 – Earthwork for material and installation to be incorporated into the work.
 - 8. Division 32 – Exterior Improvements for material and installation of pavements; and seeding.
 - 9. Division 33 – Utilities for material and installation of sanitary sewage system, and hydrants.
 - 10. Division 35 – Water way and marine construction, material and installation of the slide gates.
 - 11. Division 40 – Process Integration for material, equipment, system integration to be incorporated into the work including sluice, process pipe hangers and supports, process valves, pipes and fittings, instrumentation and system integration.
 - 12. Division 43 - Process Liquid Handling for the pumps, material and installation to be incorporated into the work.

13. Division 46 – Wastewater Equipment materials, equipment and installation to be incorporated into the work.
- C. In general, these Specifications describe the work to be performed by the various trades, other than work specifically excluded. It shall be the responsibility of the Contractor and Subcontractors to perform all work incidental to their trade, whether or not specific mention is made of each item, unless such incidentals are included under another Item.
- D. It is advised that the Contractor and all Subcontractors familiarize themselves with the contents of the complete Specifications, particularly for the trades preceding, following, related or adjacent to their work.

1.4 PROJECT DESCRIPTION

- A. The City of Sunbury WWTP is active and meeting permit requirements. The current WWTP is designed to treat an average daily flow of 1.125 MGD and Peak Hourly Flow of 4.0 MGD, discharging treated effluent to the Prairie Run. The last City of Sunbury WWTP Improvements was conducted in 2004, Contract No. 2002-02. The City of Sunbury WWTP Improvements Project will expand WWTP operating capacity to Average Day Design Flow of 2.0 MGD and Peak Hourly Flow of 6.0 MGD.
- B. The Contract Drawings contain detailed description of work to be furnished for the proposed WWTP Improvements Project. The scope of work is divided into the Series, presented, identified under “Sheet Name”. The project includes the following improvements:
 1. Series 00 - General: Sheets 00G-01 through 00G-10 show the organization of the drawings; General notes; Valve Schedule; Process Flow Diagram; and Hydraulic Profile and Design Criteria.
 2. Series 01 - Site Improvements (Civil): Overall Site Plan of the Existing WWTP and Proposed Site Improvements.
 3. Series 10 - Headworks Improvements: Influent Pump Station. Selective demolishing of the existing screen equipment and an installation of the new mechanical screens. Replacement of the existing grit equipment, including but not limited to grit washer-compactor, grit pumps, and etc., and installation of the second grit tank. Contractor shall provide temporary bypassing during construction activities.
 4. Series 20 – Oxidation Ditch Improvements include, but not limited to installation of the new mixers, drives and bearing, instrumentation and controls. Slitter Box improvements.
 - a. Contractor shall provide temporary Oxidation Ditch Splitter Box bypassing during this construction activities.
 - 1) Temporary gravity line from the Grit effluent channel directing all flow to the Oxidation Ditch No. 1/2.
 - 2) Temporary RAS line shall be provided by the Contractor during construction of the new RAS line.
 5. Series 30 – Secondary Clarifiers No. 1 & 2 mechanisms replacement. Installation of the new Final Clarifier No. 3. Slitter Box improvements. Contractor shall provide temporary bypassing during construction activities.
 6. Series 40 – Tertiary Filtration: New Tertiary Filtration treatment shall be provided including, but not limited to: Rapid Mix/Coagulation/Flocculation tanks; Tertiary Filtration Building with

the Drumfilters equipment, polymer feed; Tertiary Filter Pump Station and Drain Pump Station.

7. Series 50 – UV Disinfection/Post Aeration/Parshall Flume: Convert existing Aerobic Digester Tank No. 4 to Post Aeration/UV Disinfection and Parshall Flume. After completion, remove existing UV Disinfection equipment from the tank and convert it to the Sludge Wet Well No. 2
8. Series 60 – RAS/WAS Pump Station Improvements: Replace existing RAS pumps with new submersible pumps. Contractor shall provide temporary bypassing of RAS to the Oxidation Ditch during construction activities.
9. Series 70 – Aerobic Digesters No. 1-4 and Sludge Wet Well. Replacing old diffusers with new coarse bubble diffusers. Demolition of the existing gate valves, telescoping valves, butterfly valves, railings; and old blower housing. Conversion of the existing Aerobic Digester No. 4 to the Post Aeration/UV Disinfection and Parshall Flume. Provide new Aerobic Digesters No. 4 & 5. Furnish and install positive displacement blowers for Aerobic Digesters No. 4 & 5 air supply.
10. Series 80 – Sludge Transfer Lift Station: Improvements of the existing Sludge Transfer Lift Station include the construction of the above ground building, an installation of the new progressive cavity pumps and grinders, replacement, piping and valves replacement.
11. Series 90 – Sludge Transport/ Electrical Building: Replacement of the existing sludge grinders and progressing cavity pumps with the new equipment for feeding digested sludge from the Sludge Wet Well to the dewatering screw press. Replacement of the existing blowers with new positive displacement blowers for aeration of the Aerobic Digesters No. 1, 2 and 3, and Post Aeration Tank.
12. Series 100 – Sludge Dewatering: Provide new sludge dewatering equipment.
13. Series 110 – Sludge Drying Facility: Provide new Sludge Storage Area (2,520 sf) for storage dewatered sludge after dewatering. This is an Alternate bid item, A1, per Specification Section 012300.
14. Series 120 – Existing Operations Building Renovation and Improvements. This is an Alternate bid item, A2, per Specification Section 012300.

C. In general, these Specifications describe the work to be performed by the various trades, other than work specifically excluded. It shall be the responsibility of the Contractor and Subcontractors to perform all work incidental to their trade, whether or not specific mention is made of each item, unless such incidentals are included under another Item.

D. It is advised that the Contractor and all Subcontractors familiarize themselves with the contents of the complete Specifications, particularly for the trades preceding, following, related or adjacent to their work.

1.5 SCHEDULES AND SEQUENCE OF CONSTRUCTION

A. Contractor shall provide schedules for performance of the Work in accordance with the provision set forth within the General Conditions. The schedule(s) shall detail all phases of construction to completion with milestones and associated dates. The schedule(s) shall be presented in a format acceptable to the Owner and Engineer.

- B. Project Critical path items identified include:
1. Series 10 – Raw Influent Pump Station: Replacement of the existing three submersible pumps with new and installation of Pump No. 4 in the existing wetwell. Provide new Radar type level transmitter, VFDs, and pumps controls.
 - a. Contractor shall provide temporary by-passing pumping to isolate the Influent Pump Station wet well for installation of the new pumps.
 - b. Improvement to the pump station shall be scheduled during period of low wastewater flow.
 - c. Suggested wastewater by-passing is to direct plant raw influent wastewater from existing Manhole-A to the EQ Tank; install temporary submersible pump at the EQ Tank and connect the force main to the emergency line 6" quick disconnect located in the valve pit.
 2. Series 10 – Headworks Building:
 - a. Demolition of the existing mechanical screen and manual bar screen and installing two (2) new mechanical bar screens, screenings conveyors and new screening compactor. Only one screen channel can be taken out of service at a time. Construction of the Grit Tank No. 2; installation of the new grit tanks mixers; replacement of the existing grit washer and compactor unit with the new; replacement of the grit removal pumps and etc. Contractor shall schedule WWTP outage. Duration of the outage shall be for maximum of 1-day and only as approved by the Owner.
 - b. Demolition of the existing rooftop HVAC and replacement with the new HVAC unit.
 3. Series 20 – Oxidation Ditch No. 1/2, Splitter Box Improvements:
 - a. Contractor shall provide temporary bypassing before starting construction activity.
 - 1) Construct new 24-inch primary effluent gravity line from the grit effluent channel extending it to the Oxidation Ditch Splitter Box. Provide temporary connection to the 18-inch Oxidation Ditch No. 2 influent line at 45-degree elbow located before the motor operated line.
 - 2) Contractor to provide temporary force main line from the RAS/WAS valve pit emergency quick disconnect to feed RAS directly Oxidation Ditch No. 1/2.
 - b. Improvements work
 - 1) Demolition of the current weirs and installing new motor actuated sliding weir gates, total of 2 units.
 - 2) Demolition of the 10-inch RAS piping and providing 14-inch RAS DIP force main from the RAS/WAS Pump Station.
 - 3) Replacement of the 18-inch DIP Oxidation Ditch Influent Lines with 24-inch DIP. Only one line shall be replaced at a time.
 - 4) Installation of the Ultrasonic Level Sensor.
 - 5) Provide all necessary bulkheads, bypass piping and pumps as required for splitter chamber tie in work.
 4. Oxidation Ditch: Required modification to run both tanks in series.
 - a. Replace all drives, total of 6.
 - b. Provide and install new sliding gates and motor actuated valves for the Oxidation Ditch influent, effluent and RAS flow.
 - c. Provide new Control System
 - d. Only one Oxidation Ditch tank can be taken out of service at a time.

5. Series 30 – Secondary Clarifier Splitter Box
 - a. Contractor shall provide temporary bypassing before starting construction activity.
 - 1) Recommended sequence of construction is to complete construction of Secondary Clarifier No. 3 and provide new 24-inch Oxidation Ditch effluent piping temporary connected directly to the Secondary Clarifier No. 3 feed line. This will allow to remove Secondary Clarifiers No. 1 & 2, and the Splitter Box temporary from service.
 - b. Improvements
 - 1) Replacement of the 18-inch DIP Splitter Box influent with 24-inch DIP.
 - 2) Installation of the new weir gates for Final Clarifiers No. 1-3.
 - 3) Installation of the Ultrasonic Level Sensor.
6. Series 30 – Secondary Clarifiers:
 - a. Existing Secondary Clarifiers No. 1 & 2: Demolition of the existing clarifier mechanisms in its entirety, including center drive, bridge and railings and replacement with new suction header type mechanism, scum removal system, drive, bridge, railings, etc.
 - b. New Secondary Clarifier No. 3: Provide new 70-diameter Final Clarifier. Clarifier No. 3 shall be completed and brought into service before starting modifications to Final Clarifiers No. 1 and 2.
7. Series 40 – Tertiary Filtration Facility: New Tertiary Filtration Facility includes new Rapid Mix/Coagulation/Flocculation tanks, automatic backwash Discfilter equipment installed in the new Tertiary Filter Building, complete with the coagulation and polymer feed systems, and automatic control system.
8. Series 40 – Tertiary Filter Submersible Pumps Station:
 - a. Construct new Wet Well and Valve Vault equipped with new submersible pumps, total of 3, and an additional Pump No. 4 to be installed in the future.
 - b. The Valve Vault includes all necessary valves, piping and flowmeters, excess hatches as shown on the Drawings.
 - c. Provide Ultrasonic type level transmitter, VFDs, pumps' controls for a complete pumping system.
9. Series 50 – UV Disinfection / Post Aeration and Parshall Flume:
 - a. Contractor shall coordinate construction activity for the existing Aerobic Digester No. 4 with the Owner and the Engineer at least 2 weeks prior to the work.
 - b. It is suggested to remove Aerobic Digester No. 4 from operation only after completion of new Aerobic Digester No. 4 & 5 construction and the start-up of the equipment (new blowers, submersible transfer sludge pump station and etc.).
 - c. Plant Operations will assist in transferring sludge from the Aerobic Digester No. 4 to the existing Sludge Wet Well. Contractor shall remove the deposited sludge on the bottom of the tank and shall power wash the tank walls and slab.
 - d. Convert existing Aerobic Digester Tank No. 4 to the UV Disinfection/Post Aeration and Parshall Flume.
 - e. Complete UV Disinfection/Post Aeration and Parshall Flume improvements during non-disinfection season (November to April).
 - f. Keep Existing Parshall Flume in operation until new Parshall flume is constructed and ready to accept plant flow.
 - g. Install two (2) Gate Valves, one 30-inch for the Secondary Clarifier by-pass to the UV Disinfection and the other 36-inch diameter on the main to Tertiary Filter.

- h. Demolish existing UV system and provide structural improvement to convert existing UV Tank into Sludge Wet Well No. 2.
 - i. Convert existing UV Disinfection Tank into the Sludge Wet Well No. 2, install new coarse bubble diffusers.
10. Series 60 – RAS/WAS Pump Station:
- a. Contractor shall provide temporary bypassing before starting construction activity.
 - 1) Contractor to provide temporary by-pass pumping from Secondary Clarifier No. 3 directly and connect the force main emergency line 6” quick disconnect located in the RAS/WAS valve pit.
 - b. Improvements
 - 1) Replace existing RAS/WAS Pumps with new submersible pumps.
 - 2) Wetwell improvements include the replacement of the existing pump guide rails and plug valves used to drain the Secondary Clarifiers No. 1 and 2; and an installation of the new Telescoping Valve for the Secondary Clarifier No. 3 and a plug valve for draining.
 - 3) Valve Pit: Replacement of the plug valves.
 - 4) Replacement of the existing 10-inch DIP with 14-inch DIP RAS force main.
 - 5) Provide Radar type level transmitter, VFDs, pumps’ controls for a complete pumping system.
11. Series 70 - Aerobic Digesters No. 1-3 and Sludge Wet Well
- a. Contractor shall coordinate the scheduling of the construction activity for the existing Aerobic Digester No. 1-3 and the Sludge Wet Well with the Owner and Engineer at least two (2) before planning work. Plant Operations will assist in transferring sludge from the Aerobic Digester No. 1, 2 and 3 to the existing Sludge Wet Well. Only one of the existing Aerobic Digesters can be removed at a time. Contractor shall remove the deposited sludge on the bottom of the tank and shall power wash the tank walls and slab.
 - b. It is suggested to start work on this units only after completion of new Aerobic Digester No. 4 & 5 construction and the start-up of the equipment (new blowers, submersible transfer sludge pump station and etc.).
 - c. Aerobic Digesters No. 1-3 and Sludge Wet Well:
 - 1) Replace the existing gate valves, telescoping valves, butterfly valves with the new equipment.
 - 2) Replace old diffusers with the new coarse bubble diffusers.
 - d. Demolition of the old blower housing.
 - e. Replace existing railings.
12. Series 70 – New Aerobic Digester No. 4-5:
- a. Construct new Aerobic Digesters No 4 & 5, including installation of the new blowers (Blowers No. 5-7); coarse bubble diffusers; submersible pumps for the sludge transfer to the Sludge Wet Well; decant system; all necessary piping, valves and auxiliary equipment.
13. Series 80 – New Sludge Transfer Pump Station
- a. Demolition of the existing Sludge Transfer Pumps, process piping, valves as shown on the Drawings.
 - b. Install new Progressive Cavity Pumps, Grinders, piping, and valves.
 - c. Replace existing WAS magnetic flowmeter with the new.
 - d. Install new remote motor operated valves control stations and pump control panel as shown on the Drawings.

- e. Build new above grade Building to house the existing Sludge Transfer Pump Station located below the grade.
14. Series 90 – Sludge Transport and Electrical Building
 - a. Replace existing blowers located in the Sludge Transport and Electrical Building with the new Positive Displacement Blowers.
 - b. Replace existing grinders, progressive cavity pumps and plug valves with the new equipment.
 15. Series 100 – Sludge Dewatering Facility
 - a. Demolition of the Belt Filter Press and an installation of the new Screw Press
 - b. Installation of the new screw conveyor.
 - c. Construction activity shall be coordinated with the plant operation, when plant has processed (dewatered) most of sludge, and the Aerobic Digesters have most of its volume available for sludge storage during Construction.
 - d. Sludge dewatering replacement. Keep existing Belt Filter Press on site and operational until new dewatering system is ready to operate.
 16. Series 110 – Sludge Storage Facility. This is an Alternate-A1 bid item, per Specification Section 012300.
 - a. Construction of the new covered Sludge Storage Facility.
 17. Series 120 – Operations Building Renovation and Expansion. This is an Alternate-A2 bid item, per Specification Section 012300.
- C. In preparation of the schedule(s), Contractor shall take into account the following critical component work sequence required for coordination with the Engineer and the Owner:
1. Complete shop drawing submittals for all project components. Provide submittals to the Engineer for review in a timely, sequenced fashion and avoid last minute, multiple submissions.
 2. Fully mobilize to the project site and establish erosion controls and site security.
 3. Construct components and piping required for operation of new treatment train for Aerobic Digesters No. 4 and 5 and Tertiary Filtration.
 4. Modification of the existing Influent Pump Station to provide new submersible pumps. Temporary by-pass pumping is required during this construction activities.
 5. The existing mechanical screen removal and an installation of the new equipment. First install new mechanical screen in lieu of the existing manual bar screen first, followed by the replacement of the mechanical bar screen.
 6. Construct the second Grit Tank and install new equipment. Contractor shall minimize any process equipment shutdown time. Contractor shall coordinate the scheduling of the process equipment shutdown time and duration with the Owner and Engineer two (2) weeks before planned work.
 7. Modify existing treatment components of the Oxidation Ditch Splitter Chamber. Contractor shall arrange construction in such way that only one splitter chamber is removed from operation at a time. This will allow for the operation of one Oxidation Ditch unit during the installation of the new Slide Gate and replacement of the influent pipe from the splitter box to the Oxidation Ditch in the other.

8. Replacement of the RAS feed pipe to the Oxidation Ditch splitter box and to the existing Oxidation Ditch No. 1 & 2. It is suggested first to provide new RAS piping and isolation valves feeding sludge directly to the Oxidation Ditch No. 1 & 2. Next, replace main RAS pipe to the Oxidation Splitter Box with the new RAS piping.
 9. Contractor to install new Manhole No. 3 to receive gravity effluent from the Secondary Clarifiers and extending new 36-inch piping to Tertiary Filtration. Provide 18"x24" increaser to tie-in existing 18-inch effluent line from the Secondary Clarifiers 1 & 2 to Manhole No. 3. Provide one (1) 30-inch Butterfly Valve which is located on the secondary effluent by-pass to the UV Disinfection and one (1) 36-inch Butterfly Valve located on the secondary effluent to the Tertiary Filtration.
 10. Complete UV Disinfection/Post Aeration and Parshall Flume improvements during non-disinfection season (November to April).
 11. Modify RAS/WAS Pump Station and Drain Lift Station to connect new sludge line and drain from the Secondary Clarifier No. 3. Temporary by-pass pumping is required during this construction activities.
 12. Contractor shall coordinate the scheduling of the construction activity for the existing Aerobic Digester No. 1-3 and the Sludge Wet Well with the Owner and Engineer at least two (2) before planning work.
 13. Coordinate with the Owner and Engineer on dewatering improvements.
 14. Components not specifically itemized within the work sequence may be completed at any time throughout the contract period in so long as their performance is in accordance with the project milestones and that work items required for the completion of specifically itemized components are in place when required.
- D. The Contractor will be required to provide his own detailed sequence of construction in writing prior to commencing any work. The Contractor is responsible to maintain the proper operation of the WWTP during construction. Below is a probable generalized sequence of construction.
- E. The design, installation and operation for the temporary pumping system, including pumps' sizes, piping and controls shall be the Contractor's responsibility and shall be submitted for Engineer/Owner approval. Temporary by-passing shall be of adequate capacity and include all necessary controls to keep the existing WWTP under normal operating conditions. The Contractor shall coordinate with the Owner on the location of any temporary by-pass line.
- F. Contractor shall provide all items, articles, material operations or methods mentioned or scheduled on the Drawings or herein specified: including all labor, supervision, equipment, incidentals, taxes and permits necessary to complete the Work as described within the Contract Documents.
- 1.6 EXISTING SERVICES, STRUCTURES AND UNDERGROUND FACILITIES
- A. Interruption of existing utility services shall be kept to an absolute minimum and shall be limited to times approved by the owner.
 - B. If deemed necessary by the Owner, such work shall be accomplished after Owner's normal office/operational hours.

- C. Work shall not commence until all labor, materials and equipment are available and Work can continue without interruption or delay.
- D. Should uncharted or incorrectly charted piping or other utilities be encountered during installation, notify Engineer and consult with utility owner immediately for directions.
- E. Cooperate with Owner and utility companies in keeping respective services and facilities in operation and repair any damaged utilities to the satisfaction of the utility owner.
- F. Contractor shall not interrupt existing utilities serving facilities occupied and used by the Owner or others, except when permitted in writing by the Owner.
- G. Any accidental interruption of services shall be repaired immediately, including provision of temporary facilities until permanent repairs can be made.
- H. Existing underground facilities may consist of gas lines, water lines, storm sewers, and buried telephone and electric cables. The utilities shown on the Drawings are based on data furnished by the utility companies listed in the Drawings and on field observations and are believed to be reasonably accurate.
- I. Contractor shall notify the Ohio Utilities Protection Service (OUPS), (1-800-362-2764), the Oil and Gas Producer's Underground Protection Service (OGPUPS), (1-800-925-0988), and any other non-OUPS/non-OGPUPS utility a minimum of 48 hours prior to commencing work on the project to coordinate the marking of utilities in the field. Based on information made available by the various utility companies, the companies shown in the Drawings have facilities in the area.
- J. Contractor shall proceed with caution in the excavation and preparation of the Site so the exact location of structures and Underground Facilities can be determined. Contractor shall include in Contract Price any costs for temporary or permanent relocations of such structures and Underground Facilities required to complete the Work unless specifically indicated otherwise in the Specifications.
- K. Contractor shall keep an accurate and complete record of all such structures and Underground Facilities encountered and shall provide the Owner a copy of this record. The record shall include a description of the item encountered, opinion as to condition, and adequate measurements and depths so that the item can be located in the future.
- L. Contractor shall inspect all structures and underground facilities for condition and soundness. Unsound conditions shall be reported to the structure or facility owner immediately after exposing. Contractor shall not proceed with the work until the structure or facility owner has been notified. Owner shall then be given time to inspect and correct, if required, the structure or Underground Facility. Contractor shall make claim under the provisions of Articles 11 and 12 of the General Conditions should the Contractor feel a price or time adjustment is justified.
- M. Any additional costs incurred because of the failure of the Contractor to report the condition of any and all existing structure or Underground Facility encountered shall be paid by the Contractor.
- N. Whenever the Engineer deems it is necessary to explore and excavate to determine the location of existing structures and Underground Facilities, the Contractor shall make explorations and excavations for such purposes. If Contractor is required to perform additional work in making the

explorations and excavations, extra compensation will be allowed as provided for in the General Conditions.

- O. Federal regulations prohibit by-passing any sewage (or process waste) during construction operations. The Contractor shall be responsible for providing any required temporary pumping facilities, piping, etc., necessary to complete the project without bypassing treatment operations. Continuous treatment of sewage (process waste) shall be provided at the same level during construction as existed prior to construction.

1.7 PROTECTION OF WORK AND IMPROVEMENTS

- A. Contractor shall protect the property of the Owner, existing improvements, and the Work installed by the Contractor and others from abuse, damage, dust, debris, and other objectionable materials resulting from construction activities.
- B. Contractor shall provide suitable covers, partitions, or other dust and fume containment devices to suit construction operations.
- C. Contractor shall keep property, existing improvements and the Work, including structures, mains, fittings and accessories free from dirt and foreign matter at all times.
- D. Contractor shall provide temporary plugging of openings, holes and pipe ends that are existing or that the Contractor has installed.
- E. Property, improvements, and Work damaged by Contractor shall be repaired or replaced by Contractor to the satisfaction of the Owner.

1.8 CONTRACTOR USE OF SITE

- A. The existing plant is an operational plant and must remain in continual operation at all times. The Work of this Contractor, or its personnel, shall not interfere in any way with daily operations of the facility. Portions of plant may be shut down for connection of piping, electrical work, etc. for a maximum of 4 hours and then only as approved by the Owner. Request of partial shutdown shall be submitted to Engineer no less than 48 hours prior to requested shutdown period.
- B. Access to Site: Limited to areas noted on Drawings.
- C. Construction Operations: Limited to areas noted on Drawings.
- D. The Contractor will need to coordinate with the Village Administrator ahead of time for any periods of work beyond normal work hours.

END OF SECTION 011100

SECTION 011419 – USE OF SITE

PART 1 - GENERAL

1.1 GENERAL

- A. The Contractor will be allowed the use of as much of the site designated for the improvements as is necessary for his operation.

1.2 USE OF STREETS

- A. During the progress of the work, the Contractor shall make ample provisions for both vehicle and pedestrian traffic on any public street and shall indemnify and save harmless the Owner from any expense whatsoever due to their operations over said streets. The Contractor shall also provide free access to all the fire hydrants, water, and gas valves located along the line of his work. Gutters and waterways must be kept open or other provisions made for the removal of storm water. Street intersections may be blocked only one-half at a time, and the Contractor shall lay and maintain temporary driveways, bridges and crossings, such as in the opinion of the Engineer are necessary to reasonably accommodate the public.
- B. In the event of the Contractor's failure to comply with these provisions, the Owner may cause the same to be done, and may deduct the cost of such work from any monies due the Contractor under this Agreement, but the performance of such work by the Owner at its instance shall serve in no way to release the Contractor from his general or particular liability for the safety of the public or the work.
- C. The Contractor shall repair at no cost to the Owner, all existing roads, parking areas, grassed areas that are damaged due to the execution of his work. The Contractor shall remove daily all mud, soil and debris that may be tracked onto existing streets, drives, or walks by his equipment or that of subcontractors or suppliers.

1.3 CLOSING STREETS TO TRAFFIC

The Contractor may with the approval of the Engineer, close streets, or parts of streets, to vehicular traffic. The streets are to remain closed as long as the construction work or the condition of the finished work requires or as determined by the Engineer. The Engineer shall be the judge of how many streets or parts of streets it is necessary for the Contractor to close at any time, and may refuse to permit the closing of additional streets to traffic until the majority of the work on the closed streets is completed and they are opened to traffic.

1.4 RIGHTS-OF-WAY

- A. Whenever it is required to perform work within the limits of public or private property or in rights-of-way, such work shall be done in conformity with all agreements between the Owner and the owners of such. Care shall be taken to avoid injury to the premises entered, which premises shall be left in a neat and orderly condition by

the removal of rubbish and the grading of surplus materials, and the restoration of said public or private property to the same general conditions as pertained at the time of entry for work to be performed under this contract.

- B. The Contractor shall not (except after consent from the proper parties) enter or occupy with men, tools or equipment, any land outside the rights-of-way or property of the Owner.
- C. When the Contractor performs construction within 10 ft. of a right-of-way or easement line, he shall place tall stakes properly identified at points of change in width or direction of the right-of-way or easement line and at points along the line so that at least two stakes can be seen distinctly from any point on the line.

1.5 EASEMENTS

- A. Where the work is to be constructed upon easements, such easements will be secured by the Owner without cost to the Contractor. The Contractor shall not enter upon or occupy any private property outside of the limits of the easements furnished.
- B. Care shall be taken to avoid injury to the premises entered, which premises shall be left in a neat and orderly condition by the removal of rubbish and the grading of surplus materials, and the restoration of said public or private property to the same general conditions as pertained at the time of entry for work to be performed under this contract.

1.6 PROTECTING EXISTING BUILDINGS, STRUCTURES AND ROADWAYS

- A. The Contractor shall, at his own expense, shore up and protect any buildings, roadways, utilities or other public or private structures which may be encountered or endangered in the prosecution of the work, and that may not be otherwise provided for, and he shall repair and make good any damages caused to any such property by reason of his operations. All existing fences removed due to the prosecution of the work shall be replaced by the Contractor. No extra payment will be made for said work or material, but the cost of this work must be included in the price stipulated for the work to be done under this contract.

1.7 SITE FACILITIES

- A. The Contractor shall furnish and place sufficient quantities of portable toilet facilities at locations convenient for use by the Contractor's personnel, Subcontractors, the Engineer, and the Owner.

1.8 RESTORATION

- A. The contractor shall restore all areas per the plans and specifications and if not specified, at least to the condition existing prior to the start of work.

SECTION 011423 - ADDITIONAL WORK, OVERTIME

PART 1 - GENERAL

1.1 NIGHT, SUNDAY AND HOLIDAY WORK

- A. No work will be permitted at night, Sunday or legal holidays except as noted on the plans or in the case of emergency and then only upon written authorization of the Engineer. Where no emergency exists, but the Contractor feels it advantageous to work at night, Sunday or legal holidays, the Contractor shall notify the Engineer at least two (2) days in advance, requesting written permission. Any work performed during the absence of the Engineer will be done at the Contractor's risk and responsibility and may be subject to rejection upon later inspection.

END OF SECTION 011423

SECTION 012300 - ALTERNATES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes administrative and procedural requirements governing Alternates.

1.3 DEFINITIONS

- A. Definition: An alternate is an amount proposed by bidders and stated on the Bid Form for certain work defined in the Bidding Requirements that may be added to or deducted from the Base Bid amount if the Owner decides to accept a corresponding change in either the amount of construction to be completed, or in the products, materials, equipment, systems, or installation methods described in the Contract Documents.

- 1. The cost or credit for each alternate is the net addition to or deduction from the Contract Sum to incorporate the Alternate into the Work. No other adjustments are made to the Contract Sum.

1.4 PROCEDURES

- A. Coordination: Modify or adjust affected adjacent Work as necessary to completely and fully integrate that Work into the Project.

- 1. Include as part of each alternate, miscellaneous devices, accessory objects, and similar items incidental to or required for a complete installation whether or not mentioned as part of the Alternate.

- B. Notification: Immediately following the award of the Contract, notify each party involved, in writing, of the status of each alternate. Indicate whether alternates have been accepted, rejected, or deferred for later consideration. Include a complete description of negotiated modifications to alternates.

- C. Execute accepted alternates under the same conditions as other Work of this Contract.

- D. Schedule: A "Schedule of Alternates" is included at the end of this Section. Specification Sections referenced in the Schedule contain requirements for materials necessary to achieve the Work described under each alternate.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION

3.1 SCHEDULE OF ALTERNATES

- A. Alternate No. A1: This lump sum bid price shall include furnishing of all labor and material for completion of all work associated with new Sludge Storage Facility and metal building. This bid item shall include all demolitions and disposal of excess materials; all proposed pavement site work, utility work and coordination, earthwork, tools, material, labor and equipment necessary to complete the work as specified, shown on Contract Drawings, Series 110, and per Specification 133419 – Metal Building Systems, or required for the proper completion of the work.
- B. Alternate No. A2: This lump sum bid price shall include furnishing of all labor and material for the renovation of the existing Operations Building Renovation and Expansion including demolition and disposal of excess materials, excavation, site work, utility work, tools and equipment necessary to complete the work as shown on Contract Drawings, Series 120 of structural, architectural and electrical disciplines and related specification sections.

END OF SECTION 012300

SECTION 012513 – PRODUCT SUBSTITUTION PROCEDURES

PART 1 - GENERAL

1.1 MATERIALS AND EQUIPMENT

- A. In the specifications and on the Engineer's drawings, are specified and shown certain pieces of equipment and materials deemed most suitable for the service anticipated. This is not done to eliminate other equipment and materials equally as good and efficient. The Contractor shall prepare his bid on the particular materials and equipment specified. Following the award of the contract, should the Contractor desire to use other equipment and materials, he shall submit to the Owner a written request for such change and state the advantage to the Owner and the savings or additional cost involved by the proposed substitution. The determination as to whether or not such change will be permitted rests with the Owner and the Engineer.

- B. Each major item of equipment shall be inspected by a manufacturer's representative during installation and upon completion of the work. The Contractor shall supply the Engineer with a certificate of such inspection.

END OF SECTION 012513

SECTION 013119 - PROJECT MEETINGS

PART 1 - GENERAL

1.1 PRECONSTRUCTION MEETING

- A. Prior to the Contractor beginning any work on the project, the Owner will schedule and hold a preconstruction meeting to discuss all aspects of the contract work.
- B. The Contractor shall be present and be prepared to comment in detail on all aspects of his work.
- C. The Contractor shall bring to the preconstruction meeting a proposed construction progress schedule, erosion control plan, quality control program, concrete mix designs, asphalt mix designs (JMF), etc. Approval of each by the Engineer is required prior to the start of any work.
- D. Included in the construction progress schedule shall be an implementation sequence of the proposed erosion control efforts required by the contract.

1.2 PROGRESS MEETINGS

- A. Monthly progress meetings will be held at a location to be determined by the Owner on a regularly scheduled day mutually convenient to the Owner, Contractor, and Engineer.
- B. The Contractor shall provide an updated construction progress schedule and be prepared to comment in detail on all aspects of his work.

END OF SECTION 013119

DOCUMENT 013126 - EXISTING HAZARDOUS MATERIAL INFORMATION

PART 1 - GENERAL

1.1 EXISTING HAZARDOUS MATERIAL INFORMATION

- A. This Document with its referenced attachments is part of the Procurement and Contracting Requirements for the Project. They provide Owner's information for Bidders' convenience and are intended to supplement rather than serve in lieu of Bidders' own investigations. They are made available for Bidders' convenience and information. This Document and its attachments are not part of the Contract Documents.
- B. An existing asbestos report for Project, prepared by **CT Consultants, Inc.**, dated **January 26, 2024**, is available for viewing **as appended to this Project Manual**.
- C. An existing lead report for Project, prepared by **CT Consultants, Inc.**, dated **January 26, 2024**, is available for viewing **as appended to this Project Manual**.
- D. Related Requirements:
 - 1. Section 024119 "Selective Demolition" for notification requirements if materials suspected of containing hazardous materials are encountered.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF DOCUMENT 013126

SECTION 013223.02 – SURVEY AND LAYOUT DATA

PART 1 - GENERAL

1.1 REFERENCE POINTS AND STAKING

- A. The Owner shall provide a surveyor to provide all reference points and staking. The Contractor shall protect and preserve the established staking and reference points as long as required for installation of the work and field verifications by any party. He shall report to the Engineer whenever any staking or reference point is destroyed. The Contractor shall reimburse the Owner for any staking or reference points destroyed by any party.

1.2 LAYOUT OF WORK

- A. The Contractor shall lay out his work and be responsible for correct locations, elevations and dimensions of all work executed by him under this Contract. The Contractor must exercise proper precautions to verify the figures shown on the Drawings before laying out the work and will be held responsible for any error resulting from his failure to exercise such precaution. The Contractor shall insure the new construction aligns with any existing work.

END OF SECTION 013223.02

SECTION 013233 – CONSTRUCTION PHOTOGRAPHS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

1.2 SUMMARY

- A. This Section includes administrative and procedural requirements for the following:
 - 1. Preconstruction photographs.
 - 2. Periodic construction photographs.
 - 3. Final Completion construction photographs.

1.3 PROGRESS PHOTOGRAPHS

- A. Construction Photographs: Contractor shall submit electronic photographic image files within seven (7) days of taking photographs /weekly to the Engineer.
 - 1. Format: Provide photographs as cut and paste files onto Word document (maximum 4 images to a page). Save digital page files in PDF format.
 - 2. Identification: On each page of photos provide the following information:
 - a. Owner's Name
 - b. Contract Description
 - c. Contractor's Name
 - d. Description of view, indicating location, direction (by compass point) and elevation or story of construction
 - e. Date photograph was taken
- B. The General Construction Contractor shall have two (2) color photographs made of the project every three (3) weeks it is in progress. The photographs shall be of such views and taken at such times as the Engineer directs.

1.4 COORDINATION

- A. Temporary Serviced: Contractor to cooperate with photographer and provide temporary services request, including access to Project site and use of temporary facilities including temporary lighting.

PART 2 - PRODUCTS

2.1 PHOTOGRAPHIC MEDIA

- A. Digital Images: Provide images in PDF format as noted above or as otherwise posted to the website as individual photographs, with minimum sensor size of 4 megapixels.

PART 3 - EXECUTION

3.1 GENERAL

- A. Date Stamp: Unless otherwise indicated, date and time stamp each photograph as it is being taken so stamp is integral to photograph.
- B. Field Office Prints: Retain one set of prints of progress photographs in the field office at Project site, available at all times for reference. Identify photographs the same as for those posted on the project's website.

END OF SECTION 013233

SECTION 013236 – VIDEO MONITORING AND DOCUMENTATION

PART 1 - GENERAL

1.1 SCOPE

- A. Provide all labor, materials, equipment, and services, and perform all operations necessary to furnish to the Owner a complete color audio-video DVD record of the surface features within the proposed construction zone of influence. This record shall include, but not be limited to, all audio-video DVDs, storage cases, video logs, and indexes. The purpose of this coverage shall be to accurately document the pre-construction condition of these surface features.

1.2 QUALIFICATIONS

- A. The video DVD documentation shall be done by a responsible commercial firm known to be skilled and regularly engaged in the business of pre-construction color audio-video DVD documentation. The firm shall furnish such information as the Owner deems necessary to determine the ability of that firm to perform the work in accordance with the Contract specifications.

1.3 PRODUCTS

- A. The color audio-video recording delivered to the Owner shall be on a high quality DVD format.

END OF SECTION 013236

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes, but is not limited to, services performed by an independent testing laboratory. Laboratory services covered under this section are for testing materials used for field constructed elements of the work. Performance testing of manufactured items and shop fabricated materials shall be covered under their respective specification section.
- B. All testing performed under this item shall be for the protection and benefit of the Owner and shall not be construed by the Contractor as a comprehensive quality control program intended to protect the Contractor, his subcontractors, or his suppliers. The testing frequency and types of testing shall be *as scheduled herein*.
- C. Inspections, tests, and related actions specified in this section and elsewhere in the contract documents are not intended to limit the Contractor's own quality control procedures and testing, which facilitate overall compliance with requirements of the contract documents. Requirements for the Contractor to provide quality control services as required by the Engineer, the Owner, governing authorities, or other authorized entities are not limited by the provisions of this Section.
- D. The Contractor is required to cooperate with the independent testing laboratories performing required inspections, test, and similar services and the Engineer or his representative.
- E. Materials and installed work may require testing or retesting at any time during progress of work. Retesting of rejected materials or installed work shall be done at Contractor's expense.

1.2 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General Supplementary Conditions and Division 1 Specifications sections, apply to work of this section.
- B. The Contract Documents may include testing requirements furnished under other Sections. Work elements which may include other testing requirements are:
 - 1. Water distribution systems.
 - 2. Sanitary sewer systems.
 - 3. Electrical systems tested and certified by the Electrical Contractor.

1.3 SELECTION AND PAYMENT

- A. The Contractor will employ an independent testing laboratory to perform specified testing. Payment shall be incidental to the related work bid item. The laboratory shall be mutually agreed upon by the Owner, Engineer, and Contractor.

- B. Employment of testing laboratory in no way relieves the Contractor of the obligation to perform work in accordance with requirements of the contract documents.
- C. The testing laboratory and their personnel shall be under the direction of the Engineer's on-site representative, regardless of who employs their services.

1.4 REFERENCES

- A. AASHTO T-19, Standard Method of Test for Unit Weight and Voids in Aggregate.
- B. AASHTO T-37, Standard Method of Test for Sieve Analysis of mineral Filler for Road and Paving Materials.
- C. AASHTO T-230, Standard Method of Test for Determining Degree of Pavement Compaction of Bituminous Aggregate Mixtures.
- D. ASTM C-29, Standard Method of Test for Unit Weight and Voids in Aggregate.
- E. ASTM C-31, Standard Practice for Making and Curing Concrete Test Specimens in the Field.
- F. ASTM C-33, Standard Specification for Concrete Aggregates.
- G. ASTM C-39, Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens.
- H. ASTM C-40, Test Method for Organic Impurities in Fine Aggregates for Concrete.
- I. ASTM C-42, Standard Test Methods for Obtaining and Testing Drilled Cored and Sawed Beams of Concrete.
- J. ASTM C-88, Standard Test Method for Soundness of Aggregate by use of Sodium Sulfate or Magnesium Sulfate.
- K. ASTM C-94, Standard Specification for Ready-Mixed Concrete.
- L. ASTM C-117, Standard Test Method for Materials Finer than 75-um (No. 200) Sieve in Mineral Aggregates by Washing.
- M. ASTM C-136, Standard Method for Sieve Analysis of Fine and Course Aggregate.
- N. ASTM C-142, Test Method for Clay Lumps and Friable Particles in Aggregate.
- O. ASTM C-143, Standard Test Method for Slump of Hydraulic Cement Concrete.
- P. ASTM C-172, Standard Practice for Sampling Freshly Mixed Concrete.
- Q. ASTM C-173, Standard Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method.

- R. ASTM C-231, Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method.
 - S. ASTM C-535, Standard Test Method for Resistance to Degradation of Large-Size Course Aggregate by Abrasion and Impact in the Los Angeles Machine.
 - T. ASTM C-1064, Standard Test Method for Temperature of Freshly Mixed Portland Cement Concrete.
 - U. ASTM D-698, Standard Test Methods for Moisture-Density Relations of Soils and Soil-Aggregate Mixtures Using 5.5-lb. (2.49-kg) Rammer and 12-inc. (305-mm) Drop.
 - V. ASTM D-2487, Standard Test Method for Classification of Soils for engineer purposes.
 - W. ASTM D-2940, Standard Specification for Graded Aggregate Material for Bases or Subbases for Highways or Airports.
 - X. ASTM D-4253, Standard Test Method for Maximum Index Density and Unit Weight of Soils Using a Vibratory Table.
 - Y. ASTM D-4254, Standard Test Method for Minimum Index Density and Unit Weight of Soils and Calculation of Relative Density.
 - Z. ASTM D-4832, Standard Test Method for Preparation and Testing of Controlled Low Strength Material (CLSM) Test Cylinders.
 - AA. ODOT Supplement 1021, Method of Test for Determination of the Percent of Fractured Pieces in Gravel.
 - BB. ODOT Supplement 1029, Method of Test for Determining the Percentage of Deleterious Materials in Course Aggregate.
 - CC. ODOT Supplement 1036, Method of Test for Determination of Percent Air Voids in Compacted Dense Bituminous Paving Mixtures.
 - DD. ODOT Supplement 1044, Mix Design Method for Bituminous Aggregate Base.
 - EE. Uni-Bell PVC Pipe Association UNI-B-6-98 for Low Pressure Air Testing of Installed Sewer Pipe.
 - FF. STM – C969 – Standard practice for infiltration and exfiltration acceptance of installed concrete sewer pipe.
- 1.5 SUBMITTALS
- A. Prior to the start of work, submit testing laboratory name, address, and telephone number, and names of full-time (*registered Engineer*) (*specialist*) and responsible officer.
 - B. Submit copy of the testing laboratory's evaluation report issued by one of the evaluation authorities identified in Article 1.6 of this Section with memorandum of remedies of any deficiencies reported by the inspection.

- C. **Submit the chain of custody and other QA/QC procedures for each test to be utilized by the laboratory.**
- D. **Submit a sample test report for review by the Engineer to demonstrate conformance with Article 3.2 herein.**

1.6 **QUALITY ASSURANCE**

- A. The testing laboratory engaged shall be prequalified by the Ohio Department of Transportation for the types of services specified herein.
- B. The field personnel utilized to perform all field-testing and preparation shall be certified for those tests being performed.

1.6 **RESPONSIBILITIES**

A. Testing Laboratory Responsibilities:

1. Provide qualified personnel at the site. Cooperate with the Engineer and Contractor in performance of services.
2. Perform specified sampling and testing of products in accordance with the specified standards.
3. Ascertain compliance of materials and mixes with requirements of the contract documents.
4. Immediately notify the Engineer and Contractor of observed irregularities or nonconformance of work or products.
5. Perform additional tests required by the Engineer.
6. Testing personnel are to report to the Engineer or his representative upon arrival on site for instructions and requirements. Prior to leaving the site, furnish the Engineer or his representative all test results whether in a formal or informal format.
7. Attend preconstruction meetings and progress meetings.

B. Contractor Responsibilities:

1. Provide access to materials proposed to be used which require testing.
2. Cooperate with laboratory personnel and provide access to the work.
3. Provide incidental labor and facilities:
 - a. To provide access to work to be tested.
 - b. To obtain and handle samples at the site or at the source of products to be tested.
 - c. To facilitate tests.
 - d. To provide storage and curing of test samples as required by the testing laboratory.
 - e. Notify the Engineer 24 hours prior to expected time for operations requiring testing services for scheduling purposes. Materials will not be permitted to be placed without the proper testing being performed in conformance with this Section.

1.7 **LIMITS OF LABORATORY AUTHORITY**

- A. **The laboratory may not release, revoke, alter, or enlarge the requirements of the contract documents.**
- B. **The laboratory may not approve or accept any portion of the work.**

- C. The laboratory may not assume any duties of the Contractor.
- D. The laboratory has no authority to stop the work.

1.8 SCHEDULE OF TESTS

A. Testing anticipated on this project shall include, but is not limited to:

1. Earthwork
2. Special backfill material sieve analysis per ASTM C-136, one test per source.
3. On-site trench backfill analysis per ASTM D-2487, as directed by Engineer.
4. Pipe bedding and cover sieve analysis per ASTM C-136, one test per source.
5. Drainage fill sieve analysis per ASTM C-136, one test per source.
6. Soil compaction per ASTM D-698.
 - a. Embankment testing shall be at least one (1) test/5,000 S.F. of each lift;
 - b. Trench backfill testing shall be at least one (1) test/50 L.F. of each lift;
 - c. Subgrade and/or subbase testing shall be at least one (1) test/200 L.F. of pavement or 5,000 S.F. of slabs subject to greater frequency due to soil conditions or Engineer's direction.
7. Backfill compaction per ASTM D-4253 and D-4254, one test per 50 L.F. of each lift.
8. Low Strength Mortar testing per ASTM D-4832.

B. Concrete

1. Concrete aggregate deleterious substances per ASTM C-40, ASTM C-117, and ASTM C-142, one test per source.
2. Concrete aggregate abrasion per ASTM C-535, one test per source.
3. Sodium sulfate soundness of coarse aggregate per ASTM C-88, one test per source.
4. Sampling Fresh Concrete: ASTM C-172, except modified for slump to comply with ASTM C 94.
 - a. When cylinders and/or beam samples are made, the slumps and air test shall be made using concrete from the same batch.
 - b. Slump: ASTM C-143; one test at point of discharge each time a set of compression test specimens is made; additional tests when concrete consistency seems to have changed.
 - c. Air Content: ASTM C-173, volumetric method of lightweight concrete; ASTM C-231 pressure method for normal weight concrete; at least one for each strength test of each type of air-entrained concrete, and each time a set of compression test specimens is made.
 - d. Concrete Temperature: ASTM C-1064, test hourly when air temperature is 40° F. (4° C.) and below, and when 80° F. (27° C.) and above; and each time a set of compression test specimens is made.
 - e. Compression Test Specimen: ASTM C-31; one set of 4 standard cylinders for each compressive strength test, unless otherwise directed. Mold and store cylinders for laboratory cured test specimens except when field-cure test specimens are required.
 - f. Compressive Strength Tests: ASTM C-39; one set for each day's pour exceeding 5 cubic yards plus additional sets for each 50 cubic yards over and above the first 25 cubic yards of each concrete class placed in any one day; one specimen tested at 7 days, two specimens tested at 28 days, and one specimen retained in reserve for later testing if required. A strength test shall be the average of the strengths of two cylinders made from the same sample of concrete and tested at 28 days.

- 1) When frequency of testing will provide less than 5 strength tests for a given class of concrete, conduct testing from at least 5 randomly selected batches or from each batch if fewer than 5 are used.
- 2) Strength level of concrete will be considered satisfactory if averages of sets of three consecutive strength test results equal or exceed specified compressive strength, and no individual strength test result falls below specified compressive strength by more than 500 psi.
- g. Two (2) tests beams shall be made for each 250 square yards of concrete pavement and/or slabs on grade placed.
 - 1) For traffic to be allowed on pavement or slab, the modulus of rupture shall be a minimum of 600 psi for Class C concrete or 400 psi for ODOT Class MS or FS.
- h. When cylinders and/or beam samples are made, the slumps and air test shall be made using concrete from the same batch.
5. Nondestructive Testing: Penetration resistance, sonoscope, or other nondestructive devices may be permitted but shall not be used as the sole basis for acceptance or rejection.
6. Additional Tests: The testing service will make additional tests of in-place concrete when test results indicate specified concrete strengths and other characteristics have not been attained in the structure, as directed by Engineer. Testing service may conduct tests to determine adequacy of concrete by cored cylinders complying with ASTM C 42, or by other methods as directed.
 - a. Contractor shall pay for such tests conducted, and any other additional testing as may be required, when unacceptable concrete is verified.

C. Pavement

1. Aggregate base sieve analysis per ASTM D-2940, one test per source.
2. Sodium sulfate soundness of aggregate base per ASTM C-88, one test per source.
3. Percent of fractured pieces for aggregate base per ODOT Supplement 1021, one test per source.

D. Asphalt

1. Provide testing for mixture acceptance in accordance with Ohio Department of Transportation Procedures. The person performing the testing must have a current Level 1 Bituminous Concrete approval from ODOT.

E. Sewers

1. Deflection Testing
 - a. All thermoplastic gravity sanitary sewer pipe shall be tested for allowable deflection.
 - b. Deflection tests shall be performed before final acceptance and no sooner than thirty (30) days after installation of final backfill
 - c. Maximum allowable pipe deflection shall be five (5) percent of the average inside diameter for the size and class of pipe specified.
 - d. Acceptance testing shall be performed with a non-adjustable "go, no-go" mandrel with a minimum of eight (8) contact points. Adjustable mandrels for acceptance testing shall be used only with permission of the Engineer.
 - e. The mandrel size shall be ninety-five (95) percent of the average inside diameter for the size and class of pipe specified.
 - f. If the "go, no-go" mandrel will not pass through a section of pipe a deflectometer or adjustable mandrel may be used to determine the extent and/or severity of the non-

acceptable area. A "go, no-go" mandrel shall be re-run through the pipe section for final acceptance testing at no additional cost to the Owner.

- g. The Contractor or subcontractor performing the test shall be experienced and qualified to perform deflection testing with the equipment and procedures utilized. The contractor shall provide all labor, materials, tools and equipment necessary to clean and test all sections of sewer pipe, locate deficient areas, repair, deficient areas, and retest all repaired areas.
 - h. All sewer runs shall be cleaned prior to testing.
 - i. The acceptance test shall be performed without mechanical pulling devices.
 - j. All pipe failing the deflection test shall be exposed, repaired or replaced and retested at no additional cost to the Owner.
2. Leakage Testing
- a. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.
 - b. The Contractor shall perform sufficient tests to determine that the installation of all pipe materials have been as specified and that test results are in accordance with those required for approval of the installation.
 - c. The Contractor shall furnish all pressure gauges, suitable pump or pumps, pipes, test heads, and any other apparatus and materials used for these tests. These tests are to be considered as part of the work, and no additional compensation shall be made.
 - d. The tests shall be conducted under the direction of the Engineer or an appointed agent. Any testing done without direction and supervision as specified shall not be considered as a proper means of approval.
 - e. The Contractor may obtain water for testing as may be required by observing the rules and regulations enforced in the municipality in which the work is being done.
 - f. In addition to requirements of these specifications, comply with manufacturer's instructions and recommendations for work.
3. Infiltration and Exfiltration Testing
- a. All sewers shall be tested using an exfiltration test or, where specifically allowed in writing by the Engineer, an infiltration test.
 - b. All sewers shall be tested. No visible leakage in the sewers or manholes shall be permitted.
 - c. Bulkheads shall be used to isolate the test sections as required to perform the work. All service laterals, stubs and fittings shall be plugged or capped at the connection to the test section.
 - d. Each manhole run shall be tested separately.
4. Exfiltration Testing
- a. The test shall be performed first with a minimum head of water of three (3) feet above the top of the high end of the sewer or two (2) feet above the high end of the highest lateral in the section or sections to be tested, or three (3) feet above the existing groundwater elevation, whichever is higher.
 - b. The exfiltration test shall be conducted between two manholes by sealing the downstream end of the test section and all inlet sewers at the upstream manhole with pipe stoppers.
 - c. The average internal pressure in the system shall not exceed 11.6 feet of water or 5 psi and the maximum internal pipe pressure at the lowest end shall not exceed 23 feet of water or 10 psi.
 - d. Water shall be added to the pipe section at a steady rate from the upstream manhole to allow air to escape from the sewer until the water is at the specified level above the crown of the pipe. The water may stand in the pipe and manhole up to seventy-

two (72) hours prior to measurement of leakage to allow for absorption by the pipe and bleeding of air. After absorption into the pipe and manhole has stabilized, the water in the upstream manhole shall be brought to test level.

- e. The leakage rate shall be determined by measurement of the drop in water elevation measured in the upstream manhole and the loss of water calculated. The test period shall be a minimum of sixty (60) minutes duration. Use the following table to determine loss of water as measured in the manhole:

Water Level Change in Test Manhole		Volume of Leakage	
		4 Ft. Dia. MH (Gals.)	5 Ft. Dia. MH (Gals.)
(Inches)	(Feet)		
1/8	0.01	0.98	1.53
1/4	0.02	1.96	3.06
3/8	0.03	2.94	4.59
1/2	0.04	3.92	6.12
5/8	0.05	4.90	7.65
3/4	0.06	5.87	9.18
7/8	0.07	6.85	10.71
1	0.08	7.83	12.24
1-1/8	0.09	8.81	13.77
1-1/4	0.10	9.79	15.30
1-3/8	0.11	10.77	16.83
1-1/2	0.12	11.75	18.36
1-5/8	0.13	12.72	19.89
1-3/4	0.14	13.71	21.42
1-7/8	0.16	14.69	22.90
2	0.17	15.67	24.48

5. Infiltration Testing

- a. An infiltration test shall be conducted for all sections of sewer, only when the ground water level is two (2) feet or more above the elevation of the inside crown of pipe at the upstream limit of the section being tested.
- b. The use of well point pumps or other dewatering devices shall have been discontinued for 24 hours prior to testing to permit the groundwater table to return to a static condition.
- c. The leakage rate shall be measured by a weir, by determination of the time required to fill a container of known volume, or other measuring device approved by the Engineer in the lower end of the sewer section to be tested.
- d. The incoming sewer or sewers in the upper end of the test section shall be securely sealed.
- e. Allowable Leakage
 - 1) The maximum allowable leakage for either infiltration or exfiltration shall be 50 gallons per inch of internal pipe diameter per mile per day.
 - 2) If actual leakage measured exceeds the limits specified, the Contractor must locate and repair or remove and replace the defective pipe sections to the satisfaction of the Engineer and retest the section accordingly at no additional cost to the Owner.
 - 3) All sanitary manholes shall be tested separately by using an exfiltration test (or infiltration test where groundwater conditions permit) to two (2) feet above the highest joint with no measurable leakage for a one-hour test.

6. Low Pressure Air Testing
- a. PVC sanitary sewers 54-inch diameter and less may be air tested as specified. If the groundwater level is two (2) feet or more above the top of the pipe at the upstream end or if the air pressure required for the test is greater than 5 psig, the air test method should not be used for RCP sanitary sewers.
 - b. Each manhole run shall be tested separately, unless otherwise approved by the Engineer, as the construction progresses. Backfill shall be brought to final grade before testing. Testing shall be done prior to surface restoration, and preferably with not more than four (4) manhole runs constructed ahead of testing.
 - c. Test equipment consists of valves and pressure gages to control airflow and to monitor pressure within the test section.
 - d. The sewer shall be flushed and cleaned prior to testing to clean out any debris. The pipe surface should be wet for more consistent results.
 - e. The section of pipe to be tested shall be plugged at each end and the ends of laterals, stubs and fittings to be included in the test section shall be plugged and securely braced to prevent air leakage, and possible blowouts.
 - f. Equipment used shall meet the following minimum requirements and be approved by the Engineer:
 - 1) Pneumatic plugs shall have a sealing length equal to or greater than the diameter of the pipe to be inspected.
 - 2) Pneumatic plugs shall resist internal test pressures without requiring external bracing or blocking.
 - 3) All air used shall pass through a single control panel.
 - 4) Three (3) individual hoses shall be used for the following connections:
 - a) From control panel to pneumatic plugs for inflation.
 - b) From control panel to sealed line for introducing the low pressure air.
 - c) From sealed line to control panel for continually monitoring the air pressure rise in the sealed line.
 - g. All pneumatic plugs shall be seal tested before being used in the actual test installation. One length of pipe shall be laid on the ground and sealed at both ends with the pneumatic plugs to be used for the test. The sealed pipe shall be pressurized to 9 psig. The plugs must hold against this pressure without having to be braced. No persons shall be allowed in the alignment of the pipe during plug testing.
 - h. After a manhole to manhole run of pipe has been backfilled and cleaned, and the pneumatic plugs are checked by the above procedure, the plugs shall be placed in the line at each manhole. Low pressure air shall be slowly introduced into this sealed line until the internal air pressure reaches approximately 4 psig greater than the average groundwater back pressure, but not greater than 9 psig for PVC pipe or 5 psig for RCP.
 - i. In areas where groundwater is known to exist, the Contractor must determine the average groundwater back pressure. The Contractor shall install a 1/2-inch diameter capped pipe nipple, approximately 10 inches long, through the manhole wall on top of one of the sanitary sewer lines entering the manhole. See Figure No. 1. This shall be done at the time the sanitary sewer line is installed or install an 8-inch diameter stand pipe outside of the manhole backfilled with a column of clean stone of 2-inch minimum diameter to subgrade. Immediately prior to the performance of the low pressure air test, the ground water back pressure shall be determined by removing the pipe cap, blowing air through the pipe nipple into the ground so as to clear it, and then connecting a clear plastic tube to the nipple. The plastic tube shall be vertical and a measurement of the height, in feet of water over the invert of the pipe

shall be taken after the water has stopped rising in this plastic tube. This height, divided by 2.307, will equal the average groundwater back pressure.

- j. At least two (2) minutes shall be allowed for the air to stabilize when the specified internal air pressure has been obtained. When the pressure has stabilized and is at or above 3.5 psig, the air hose from the control panel to the air supply shall be disconnected. The portion of the line being tested shall be termed "acceptable" if the time required in minutes for the pressure to decrease from 3.5 to 2.5 psig (greater than the average groundwater back pressure calculated) shall not be less than the time in the tables in Reference Table 1.
 - k. If a one (1) psi drop in pressure does not occur within the test time, the line has passed. If the pressure drop is more than one (1) psi during the test time, the line is presumed to have failed the test. If the line fails the test, segmented testing may establish the location of any leaks.
 - l. The Contractor must repair the leak or remove and replace the defective pipe section and re-test the section to the satisfaction of the Engineer at no additional cost to the Owner.
 - m. The pneumatic plugs must be installed in such a way as to prevent blowouts. Inasmuch as a force of 250 pounds is exerted on an 8-inch plug by an internal pipe pressure of 5 psi, it should be realized that sudden expulsion of a poorly installed plug or a plug, which is partially deflated before the pipe pressure is released, can be dangerous.
 - n. The Contractor should internally restrain or externally brace the plugs to the manhole wall as an added safety precaution throughout the test.
 - o. Pressurizing equipment shall include a regulator or relief valve set at no higher than 9 psig for PVC pipe or 5 psig for RCP pipe to avoid over-pressurizing and damaging an otherwise acceptable line.
 - p. No one shall be allowed in the trench or manholes during testing.
 - q. Plugs shall not be removed until all pressure has been released.
 - 1) All sanitary manholes shall be tested separately by using an exfiltration test (or infiltration test where groundwater conditions permit) to two (2) feet above the highest joint with no measurable leakage for a one hour test.
 - 2) The air test data sheet marked Exhibit "A" at the end of this section shall be filled out for each section of piping tested in this manner.
 - 3) Testing concrete pipe sewer lines by the low-pressure air test method will be per ASTM C924-02 and C1103.
7. Hydrostatic Testing – Pressure Pipe, For Watermain and Force Main
- a. The pipe to be tested must be sufficiently backfilled to prevent movement while under test pressure.
 - b. Joint restraint at fittings should be permanent and constructed to withstand test pressure. If concrete thrust blocks are used, sufficient time must be allowed before testing to permit the concrete to cure. A cure time of seven (7) days is recommended when Type I Portland Cement is used; three (3) days is recommended when Type III high-early Portland Cement is used.
 - c. Test ends should be restrained to withstand the appreciable thrusts that are developed under test pressure.
 - d. Air pressure testing of installed pressure pipe is expressly prohibited.
 - e. Any testing performed without the knowledge of the Engineer shall not be considered a test for the purpose of this specification.
 - f. The hydrostatic testing sheet marked "Exhibit D" following this section shall be filled out for each section of piping tested in this manner.

- g. After the pipe has been installed and partially backfilled (if applicable) subject all newly installed pipe, or any valved sections of it in such lengths of the force main as determined by the responsible agency, unless otherwise specified, to a hydrostatic pressure test equal to 1-1/2 times the line working pressure (50% over the working pressure) but not less than 1.25 times the working pressure at the highest point along the test section; but, in no case, shall such force mains be tested at less than 150 pounds per square inch.. The duration of each test shall be at least 2 hours.
 - h. Each section of pipeline shall be slowly filled with water and the specified test pressure, measured at the point of lowest elevation, shall be applied by means of a booster pump connected to the pipe in a manner satisfactory to the Engineer. The duration of the test shall be for a minimum of sixty (60) minutes.
 - i. No pipe installation will be accepted unless the leakage rate for the section of pipe being tested does not exceed a rate as shown on hydrostatic test chart, during a 24-hour test duration.
 - j. The Contractor shall furnish suitable means for determining the quantity of water lost by leakage during the test.
8. Manhole Vacuum Testing
- a. Temporarily plug all pipe entering the manhole. Each plug must be installed at a location beyond the manhole/pipe gasket (i.e. outside the manhole wall), and shall be braced to prevent the plug or pipe from being drawn into the Manhole.
 - b. The test head shall be placed inside the rim of the cast iron frame at the top of the manhole and inflated, in accordance with the manufacturer's recommendations.
 - c. A vacuum of at least 10 inches of mercury (10" Hg) shall be drawn on the manhole. Shut the line on the vacuum line to the manhole and shut off the pump or disconnect the vacuum line from the pump.
 - d. The pressure gauge shall be liquid filled, having a 3.5" diameter face with a reading from zero to thirty inches of mercury.
 - e. The manhole shall be considered to pass the vacuum test if the vacuum reading does not drop more than 1" Hg (i.e from 10" to 9" Hg) during the Table 1 minimum test time.
 - f. If a manhole fails the vacuum test, the manhole shall be repaired with non-shrinkable grout or other material or method approved by the engineer. The manhole surfaces shall be properly prepared prior to any repairs. Once the repair material has cured according to the manufacturer's recommendations, the vacuum test shall be repeated. This process shall continue until a satisfactory test is obtained.
 - g. All temporary plugs and braces shall be removed after each test.

PART 2 - PRODUCTS (NOT APPLICABLE)

PART 3 - EXECUTION

3.1 SEQUENCING AND SCHEDULING

- A. The Contractor shall coordinate the sequence of work activities so as to accommodate required testing and shall allow sufficient time for testing of materials by the laboratory so as to cause no delay in the work or the work of any other Contractor. In addition, the Contractor shall coordinate his work so as to avoid the necessity of removing and replacing work to accommodate inspections and tests.

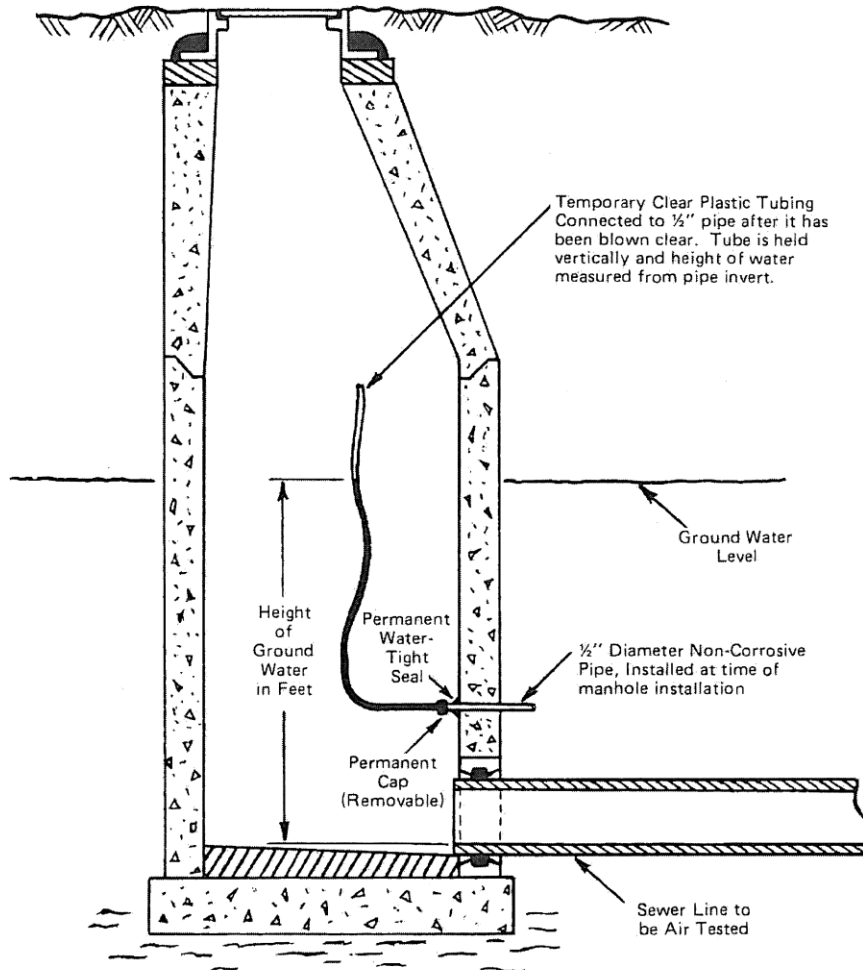
3.2 LABORATORY TEST RESULTS

- A. The testing laboratory shall submit a certified written report of each inspection, test, or similar service concurrently to the Owner, Engineer, and Contractor.
- B. Written reports of each inspection, test, or similar service shall include, but not be limited to, the following:
 - 1. Name of testing laboratory.
 - 2. Project name and construction contract reference number.
 - 3. Dates and locations of samples and tests or inspections.
 - 4. Date of report.
 - 5. Names of individuals making the inspection or test.
 - 6. Designation of the work and test method.
 - 7. Test results.
 - 8. Notation of significant ambient conditions at the time of sample taking and testing.

END OF SECTION 013319

FIGURE NO. 1

**MANHOLE CROSS-SECTIONAL VIEW
OF THE PROPER METHOD FOR
DETERMINING GROUND WATER HEIGHT**



AIR TEST DATA SHEET
PIPE TESTING FORM

NOTE: Pressurize pipe to 4.5 P.S.I.F. and let stabilize for 5 minutes. Pressure should then be backed off to 4.0 P.S.I.G. and test time started.

JOB NAME: SANITARY STORM DATE: _____
 JOB LOCATION: TEST COMPANY: _____
 JOB NO. PROJECT REP: _____
 SPECIFIED PRESSURE DROP () P.S.I.G. BASE PRESSURE: 4.0 P.S.I.G. PIPE MATERIAL: _____
 (See Table 1 or Table II for Reference) (Note: No test shall exceed 9.0 P.S.I.G.)

PIPE SECTION UNDER TEST			PIPE DIAMETER	PIPE LENGTH	GROUND WATER DEPTH	BASE P.S.I.G. PLUS GROUND WATER ADJ. (-2.31=P.S.I.G.)	TEST TIME DURATION	TEST START TIME	TEST STOP TIME	TEST TIME ELAPSED	PASS FAIL P or F
UPSTREAM MH/STATION	DN-STREAM MH/STATION										

*Identify any section(s) that failed:
 *Leak (was) (was not) located. Method used:
 REMARKS:

TABLE I

Minimum specified time required for a 1.0 P.S.I.G. Pressure Drop

1 Pipe Dia	2 Minimum Time	3 Length for Minimum Time	4 Time for Longer Length	Specification Time for Length (L) Shown (min:sec)							
				100	150	200	250	300	350	400	450
inch	min:sec	ft	sec	ft	ft	ft	ft	ft	ft	ft	ft
4	3:46	597	.380 L	3:46	3:46	3:46	3:46	3:46	3:46	3:46	3:46
6	5:40	398	.854 L	5:40	5:40	5:40	5:40	5:40	5:40	5:42	6:24
8	7:34	298	1.520 L	7:34	7:34	7:34	7:34	7:36	8:52	10:08	11:24
10	9:26	239	2.374 L	9:26	9:26	9:26	9:53	11:52	13:51	15:49	17:48
12	11:20	199	3.418 L	11:20	11:20	11:24	14:15	17:05	19:56	22:47	25:38
15	14:10	159	5.342 L	14:10	14:10	17:48	22:15	26:42	31:09	35:36	40:04
18	17:00	133	7.692 L	17:00	19:13	25:38	32:03	38:27	44:52	51:16	57:41
21	19:50	114	10.470 L	19:50	26:10	34:54	43:37	52:21	61:00	69:48	78:31
24	22:40	99	13.674 L	22:47	34:11	45:34	56:58	68:22	79:46	91:10	102:33
27	25:30	88	17.306 L	28:51	43:16	57:41	72:07	86:32	100:57	115:22	129:48
30	28:20	80	21.366 L	35:37	53:25	71:13	89:02	106:50	124:38	142:26	160:15
33	31:10	72	28.852 L	43:05	64:38	86:10	107:43	129:16	150:43	172:21	193:53
36	34:00	66	30.768 L	51:17	76:55	102:34	128:12	153:50	179:29	205:07	230:46
42	39:48	57	41.883 L	69:48	104:42	139:37	174:30	209:24	244:19	279:13	314:07
48	45:34	50	54.705 L	91:10	136:45	182:21	227:55	273:31	319:06	364:42	410:17
54	51:02	44	69.236 L	115:24	173:05	230:47	288:29	346:11	403:53	461:34	519:16
60	56:40	40	85.476 L	142:28	213:41	284:55	356:09	427:23	498:37	569:50	641:04

for size and length of pipe indicated for Q = 0.0015

NOTE: If there has been no leakage, (zero P.S.I.G. drop), after one hour of testing, the test shall be accepted and the test complete. (See Section 7.5)

TABLE II

Minimum specified time required for a 0.5 P.S.I.G. Pressure Drop
for size and length of pipe indicated for Q = 0.0015

1 Pipe Dia	2 Minimum Time	3 Length for Minimum Time	4 Time for Longer Length	Specification Time for Length (L) Shown (min:sec)								
				100	100	100	100	100	100	100	100	
inch	min:sec	ft	sec	ft	ft	ft	ft	ft	ft	ft	ft	ft
4	1:53	597	.190 L	1:53	1:53	1:53	1:53	1:53	1:53	1:53	1:53	1:53
6	2:50	398	.427 L	2:50	2:50	2:50	2:50	2:50	2:50	2:50	2:51	3:12
8	3:47	298	.760 L	3:47	3:47	3:47	3:47	3:48	4:26	5:04	5:42	5:42
10	4:43	239	1.187 L	4:43	4:43	4:43	4:57	5:56	6:55	7:54	8:54	8:54
12	5:40	199	1.709 L	5:40	5:40	5:42	7:08	8:33	9:58	11:24	12:50	12:50
15	7:05	159	2.671 L	7:05	7:05	8:54	11:08	13:21	15:35	17:48	20:02	20:02
18	8:30	133	3.846 L	8:30	9:37	12:49	16:01	19:14	22:26	25:38	28:51	28:51
21	9:55	114	5.235 L	9:55	13:05	17:27	21:49	26:11	30:32	34:54	39:16	39:16
24	11:20	99	6.837 L	11:24	17:57	22:48	28:30	34:11	39:53	45:35	51:17	51:17
27	12:45	88	8.653 L	14:25	21:38	28:51	36:04	43:16	50:30	57:42	64:54	64:54
30	14:10	80	10.683 L	17:48	26:43	35:37	44:31	53:25	62:19	71:13	80:07	80:07
33	15:35	72	12.926 L	21:33	32:19	43:56	53:52	64:38	75:24	86:10	96:57	96:57
36	17:00	66	15.384 L	25:39	38:28	51:17	64:06	76:55	89:44	102:34	115:23	115:23
42	19:54	57	20.942 L	34:54	52:21	69:49	87:15	104:42	122:10	139:37	157:04	157:04
48	22:47	50	27.352 L	45:35	68:23	91:11	113:58	136:46	159:33	182:21	205:09	205:09
54	25:31	44	34.618 L	57:42	86:33	115:24	144:15	173:05	201:56	230:47	259:38	259:38
60	28:20	40	42.738 L	71:14	106:51	142:28	178:05	213:41	249:18	284:55	320:32	320:32

NOTE: If there has been no leakage, (zero P.S.I.G. drop), after one hour of testing, the test shall be accepted and the test complete. (See Section 7.5)

CT CONSULTANTS, INC.
 HYDROSTATIC LEAKAGE TEST

JOB. NO. _____ PROJECT: _____

CONTRACTOR: _____ CLIENT: _____

WATERLINE TESTED AT: _____
 (Street Name) (Station of Gauge)

FROM STATION _____ TO STATION _____ ON _____

WATERLINE SIZE _____ TYPE _____

TESTED _____ AT _____ PSI _____ FOR _____
 TOTAL L.F. PIPE SIZE DURATION

ALLOWABLE LEAKAGE _____ PER 1,000 L.F. OR _____ PER _____
 GALS./HR. TOTAL GALS. TOTAL L.F.

1ST TEST _____ AND _____
 PASS / FAIL PRESSURE LOST GALLONS LOST

2ND TEST _____ AND _____
 PASS / FAIL PRESSURE LOST GALLONS LOST

APPROVED BY _____
 (INSPECTOR)

COMMENTS: _____

ALLOWABLE LEAKAGE PER 1,000 FEET OF WATERMAIN:

PIPE SIZE INCH DIAMETER	ALLOWABLE LEAKAGE GALS. / 1,000 FEET
6	1
8	1.3
10	1.6
12	1.9
16	2.5
20	3.2
24	3.8
30	4.8
36	5.7

NOTE: IN NO CASE SHALL THE TESTED SECTION EXCEED 2,000 FEET IN LENGTH.



PROJECT: _____ SHEET NO. 1 OF _____

JOB NO. _____ STREET: _____

CONTRACTOR: _____ PROJECT REP: _____

MANHOLE VACUUM TEST

M.H. NO.	M.H. Diameter (in.)	M.H. Depth (ft.) (btm.m.h. cover to shelf)	Vacuum Required (in Hg)	Vacuum Attained (in Hg)	Vacuum Drop (in Hg)	Holding Time Required (sec.)	Pass/Fail	Date Tested	Contractor Attest	Engineer Attest	Remarks

TABLE 1 – Minimum Test Times for Various Manhole Diameter										
Depth (ft)	Diameter, in.									
	30	33	36	42	48	54	60	66	72	72
8	11	12	14	17	20	23	26	29	33	33
10	14	15	18	21	25	29	33	36	41	41
12	17	18	21	25	30	35	39	43	49	49
14	20	21	25	30	35	41	46	51	57	57
16	22	24	29	34	40	46	52	58	67	67
18	25	27	32	38	45	52	59	65	73	73
20	28	30	35	42	50	53	65	72	81	81
22	31	33	39	46	55	64	72	79	89	89
24	33	36	42	51	59	64	78	87	97	97
26	36	39	46	55	64	75	85	94	105	105
	39	42	49	59	69	81	91	101	113	113
	42	45	53	63	74	87	98	108	121	121

Note: Allowable drop equals 1 in. Hg for time shown

PROJECT REP: _____

DATE: _____

SECTION 013323 - SHOP DRAWINGS, PRODUCT DATA AND SAMPLES

PART 1 - GENERAL

1.1 GENERAL

- A. The Contractor shall submit detailed drawings, acceptable catalog data, specifications and material certifications for all equipment and materials specified or required for the proper completion of the work.
- B. The intent of these items is to demonstrate compliance with the design concept of the work and to provide the detailed information necessary for the fabrication, assembly and installation of the work specified. It is not intended that every detail of all parts of manufactured equipment be submitted, however sufficient detail will be required to ascertain compliance with the specifications and establish the quality of the equipment proposed.

Shop Drawings shall be sufficiently clear and complete to enable the Engineer/Architect and Owner to determine that items proposed to be furnished conform to the specifications and that items delivered to the site are actually those that have been reviewed.

- C. It is emphasized that the Engineer/Architect's review of Contractor's submitted data is for general conformance to the contract drawings and specifications but subject to the detailed requirements of drawings and specifications. Although the Engineer/Architect may review submitted data in detail, such review is an effort to discover errors and omissions in Contractor's drawings. The Engineer/Architect's review shall in no way relieve the Contractor of his obligation to properly coordinate the work and to Engineer/Architect the details of the work in such manner that the purposes and intent of the contract will be achieved. Such review by the Engineer/Architect shall not be construed as placing on him or on the Owner any responsibility for the accuracy and for proper fit, functioning or performance of any phase of the work included in the contract.
- D. Shop Drawings shall be submitted in proper sequence and with due regard to the time required for checking, transmittal and review so as to cause no delay in the work. The Contractor's failure to transmit appropriate submittals to the Engineer/Architect sufficiently in advance of the work shall not be grounds for time extension.
- E. The Contractor shall submit Shop Drawings for all fabricated work and for all manufactured items required to be furnished in the Contract in accordance with the General Provisions and as specified herein. Shop Drawings shall be submitted in sufficient time to allow at least twenty-one (21) calendar days after receipt of the Shop Drawings from the Contractor for checking and processing by the Engineer/Architect.
- F. It is the responsibility of each Prime Contractor to furnish to all other Prime Contractors and especially the General Construction Contractor reviewed Shop Drawings for guidance in interfacing the various trades; i.e., sleeves, inserts, anchor bolts, terminations, and space requirements.

- G. No work shall be performed requiring Shop Drawings until same have been reviewed by Engineer/Architect.
- H. Accepted and reviewed Shop Drawings shall not be construed as approval of changes from Contract plan and specification requirements.
- I. The Engineer/Architect will review the first and second Shop Drawing item submittals at no cost to the Contractor. Review of the third submittal and any subsequent submittal will be at the Contractor's expense. Payment will be deducted from the Contract amount at a rate of 2.8 times direct labor cost plus expenses.

1.2 SUBMITTAL PROCEDURE

- A. All required submissions shall be made to the Engineer/Architect by the Prime Contractor(s) only. Any data prepared by subcontractors and suppliers and all correspondence originating with subcontractors, suppliers, etc., shall be submitted through the Contractor.
- B. Contractor shall review and approve all Shop Drawings prior to submission. Contractor's approval shall constitute a representation to Owner and Engineer/Architect that Contractor has either determined and verified all quantities, dimensions, field construction criteria, materials, catalog numbers, and similar data or assumes full responsibility for doing so, and that Contractor has reviewed or coordinated each Shop Drawing or sample with the requirements of the work and the Contract Documents.
- C. Submittal Preparation: Mark each submittal with a permanent label or page for identification. Provide the following information on the label for proper processing and recording of action taken:
 - 1. Location
 - 2. Project Name
 - 3. Contract
 - 4. Name and Address of Engineer/Architect
 - 5. Name and Address of Contractor
 - 6. Name and Address of Subcontractor
 - 7. Name and Address of Supplier
 - 8. Name of Manufacturer
 - 9. Number and Title of appropriate Specification Section
 - 10. Drawing Number and Detail References, as appropriate.
 - 11. Submittal Sequence or Log Reference Number.
 - 12. Provide a space on the label for the Contractor's review and approval markings and a space for the Engineer/Architect's "Action Stamp".
- D. Each Shop Drawing, sample and product data submitted by the Contractor shall have affixed to it the following Certification Statement including the Contractor's Company name and signed by the Contractor:

Certification Statement: By this submittal, I hereby represent that I have determined and verified all field measurements, field construction criteria, materials, dimensions, catalog numbers and similar data and I have checked and coordinated each item with other applicable approved shop drawings and all Contract requirements.

Signature

Date

Company

- E. Shop Drawings shall be submitted in not less than six (6) copies to the Engineer/Architect at the address specified at the Preconstruction Conference. Single mylar or sepia reproducible copies of simple Shop Drawings may be submitted with prior approval of the Engineer/Architect.
- F. At the time of each submission, Contractor shall in writing identify any deviations that the Shop Drawings or samples may have from the requirements of the Contract Documents.
- G. Drawings shall be clean, legible and shall show necessary working dimensions, arrangement, material finish, erection data, and like information needed to define what is to be furnished and to establish its suitability for the intended use. Specifications may be required for equipment or materials to establish any characteristics of performance where such are pertinent. Suitable catalog data sheets showing all options and marked with complete model numbers may, in certain instances, be sufficient to define the articles which it is proposed to furnish.
- H. For product which require submittal of samples, furnish samples so as not to delay fabrication, allowing the Engineer reasonable time for the consideration of the samples submitted. Properly label samples, indicating the material or product represented, its place of origin, the names of the vendor and Contractor and the name of the project for which it is intended. Ship samples prepaid. Accompany samples with pertinent data required to judge the quality and acceptability of the sample, such as certified test records and, where required for proper evaluation, certified chemical analyses.

1.3 REVIEW PROCEDURE

- A. Engineer/Architect will review with reasonable promptness all properly submitted Shop Drawings. Such review shall be only for conformance with the design concept of the Project and for compliance with the information given in the plans and specifications and shall not extend to means, methods, sequences, techniques or procedures of construction or to safety precautions or programs incident thereto.
- B. The review of a separate item as such will not constitute the review of the assembly in which the item functions. The Contractor shall submit entire systems as a package.
- C. All Shop Drawings submitted for review shall be stamped with the Engineer/Architect's action and associated comments.

- D. Except for submittals for record, information or similar purposes, where action and return is required or requested, the Engineer/Architect will review each submittal, mark to indicate action taken, and return accordingly. Compliance with specified characteristics is the Contractor's responsibility.

Action Stamp: The Engineer/Architect will stamp each submittal with a uniform, self-explanatory action stamp. The stamp will be appropriately marked, as follows, to indicate the action taken:

1. If Shop Drawings are found to be in general compliance, such review will be indicated by marking the first statement.
 2. If only minor notes in reasonable number are needed, the Engineer/Architect will make same on all copies and mark the second statement. Shop Drawings so marked need not be resubmitted.
 3. If the submitted Shop Drawings are incomplete or inadequate, the Engineer/Architect will mark the third statement, request such additional information as required, and explain the reasons for revision. The Contractor shall be responsible for revisions, and/or providing needed information, without undue delay, until such Shop Drawings are acceptable. Shop Drawings marked with No. 3 shall be completed resubmitted.
 4. If the submitted Shop Drawings are not in compliance with the Contract Documents, the Engineer/Architect will mark the fourth statement. The Contractor will be responsible to submit a new offering conforming to specific products specified herein and/or as directed per review citations.
- E. No submittal requiring a Change Order for either value or substitution or both, will be returned until the Change Order is approved or otherwise directed by the Owner.

APPLICATION FOR USE OF SUBSTITUTE ITEM

TO: _____

PROJECT: _____

SPECIFIED ITEM:

Page	Paragraph	Description
------	-----------	-------------

A. The undersigned requests consideration of the following as a substitute item in accordance with Article 6.05 of the General Conditions.

B. Change in Contract Price (indicate + or -) \$ _____

C. Attached data includes product description, specifications, drawings, photographs, references, past problems and remedies, and performance and test data adequate for evaluation of the request; applicable portions of the data are clearly identified. For consideration of the attached data as SHOP DRAWINGS, submittal shall be in accordance with requirements of Section 013323.

D. Attached data also includes a description of changes to the Contract Documents that the proposed substitution will require for its proper installation.

The undersigned certifies that the following paragraphs, unless modified by attachments are correct:

1. The proposed substitute does not affect dimensions shown on Drawings.
2. The undersigned will pay for changes to the building design, including engineering design, detailing, and construction costs caused by the requested substitution.
3. The proposed substitution will have no adverse affect on other contractors, the construction schedule, or specified warranty requirements. (If proposed substitution affects construction schedule, indicate below using + or -)

_____ CONSECUTIVE CALENDAR DAYS

4. Maintenance and service parts will be locally available for the proposed substitution.

The undersigned further states that the function, appearance, and quality of the proposed substitution are equivalent or superior to the specified item, and agrees to reimburse the OWNER for the charges of the ENGINEER for evaluating this proposed substitute item.

E. Signature: _____
Firm: _____
Address: _____

Telephone: _____ Date: _____

Attachments: _____

For use by ENGINEER:

- _____ Accepted as evidenced by affixed SHOP DRAWING REVIEW stamp.
- _____ Accepted as evidenced by included CHANGE ORDER.
- _____ Not accepted as submitted. See Remarks.
- _____ Acceptance requires completion of submittal as required for SHOP DRAWINGS.
- _____ Not accepted. Do not resubmit.

By: _____ Date: _____

Remarks: _____

TO: _____

PROJECT: _____

SPECIFIED ITEM:

Page	Paragraph	Description
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A. The undersigned requests consideration of the following as an "or-equal" item in accordance with Article 6.05 of the General Conditions.

B. Change in Contract Price (indicate + or -) \$ _____

C. Attached data includes product description, specifications, drawings, photographs, references, past problems and remedies, and performance and test data adequate for evaluation of the request; applicable portions of the data are clearly identified. For consideration of the attached data as SHOP DRAWINGS, submittal shall be in accordance with requirements of Section 013323.

D. Signature: _____
Firm: _____
Address: _____

Telephone: _____ Date: _____

Attachments: _____

For use by ENGINEER:

- _____ Accepted as evidenced by affixed SHOP DRAWING REVIEW stamp.
- _____ Accepted as evidenced by included CHANGE ORDER.
- _____ Not accepted as submitted. See Remarks.
- _____ Acceptance requires completion of submittal as required for SHOP DRAWINGS.
- _____ Not accepted. Do not resubmit.

By: _____ Date: _____

Remarks: _____

END OF SECTION 013323

SECTION 013325 - WARRANTY

PART 1 - GENERAL

1.1 DESCRIPTION

- A. This Section provides procedures and requirements for warranting the Work. The enumerated warranties herein are in no way intended to abrogate any implied warranties as associated with goods supplied under this Contract.

1.2 SUMMARY

- A. Work Included:
 - 1. Preparation of Warranties for submittals.
 - 2. Requirements for the content and submittal of Warranties.

1.3 RELATED DOCUMENTS

- A. This Section includes minimum requirements for the warranty of the equipment. See also all equipment specification sections for additional requirements.
- B. Section 013323, Shop Drawings, Product Data, and Samples.

1.4 SUBMITTALS

- A. As a part of the submittals for each item of equipment or a group of equipment items, include a DRAFT Warranty containing all of the language and terms specified.
- B. Following completion of the terms for establishment of the Warranty specified, prepare Warranties for submittal per section 013323 and the following:
 - 1. Warranties for projects or portions of the work, established on a particular date as specified herein, may be submitted as a group.
 - 2. Label each submittal with the title "WARRANTY," the project name and effective date; the Contractor's names, address and telephone number.
 - 3. A Table of Contents shall be included identifying each item with a number and title of specification section and the name of the product or Work item.
 - 4. Separate Warranty for each specification section item with index tab sheets. Label tables to conform to the Table of Contents.
- C. The Warranty shall contain, as applicable:
 - 1. Effective starting date and end date of the Warranty period.
 - 2. Statement of the terms and conditions of the Warranty, if any.
 - 3. Statement that all Operating and Maintenance information has been provided and approved.
 - 4. Statement that all training and training materials have been provided and approved.

5. Statement that the equipment or system commissioning is complete and has been reviewed and accepted by the manufacturer in accordance with provisions of the individual Sections in Divisions 1 through 46 of the Project Manual, as applicable.
 6. Certifications by the Contractor and/or Manufacturer that the statements noted above are true and correct. This certification shall be signed by a person authorized to sign documents on behalf of the Contractor.
- D. Special warranties, as required by individual Sections in Divisions 1 through 46 of the Project Manual, shall be submitted in accordance with the requirements of this Section.

PART 2 - PRODUCTS

2.1 WARRANTIES

- A. Term or Period
1. The Warranty shall extend for two (2) calendar years from the date of acceptance by Owner unless a longer period is required in the provisions of the individual Sections in Divisions 1 through 46 of the Project Manual, as applicable.
- B. Contractor's Responsibilities
1. During the Warranty period, the Contractor is responsible for repair or replacement of all failures and defects, exclusive of ordinary and routine maintenance and failures directly traceable to the lack thereof. This requirement shall be thoroughly explained by the Contractor to all prospective equipment suppliers. Repairs or replacement shall be performed in accordance with the General Conditions.

PART 3 - EXECUTION

3.1 EXECUTION OF WARRANTY

- A. The approved DRAFT Warranty will be executed and placed in effect as the FINAL Warranty on the date of Final Completion of the Work for the specific equipment item or group named in the Warranty.

END OF SECTION 013325

SECTION 013326 – PRODUCT TESTING AND CERTIFYING

PART 1 - GENERAL

1.1 QUALITY OF MATERIALS

- A. Where the specifications call for mill or shop tests, the Contractor shall furnish duplicate copies of attested manufacturer's certificates showing details of quality or performance sufficient to demonstrate conformity to contract requirements. Mill, shop or witness tests shall be subject to view by the Engineer's representative, but the Engineer's representation shall not relieve the Contractor from the necessity of furnishing certificates specified. The Engineer shall be notified by the Contractor in writing, sufficiently in advance of the time of making tests, so that proper arrangements may be made. Waiving of witness of tests by the Engineer may be in writing only by the Engineer. All costs for travel, lodging, food and transportation that are necessary for the Engineer's representative and the Owner's representative to attend witness tests shall be included in the Contractor's bid for those item(s) specifically designated as being subject to witness testing.
- B. Unless otherwise specified, all materials, equipment and articles shall be erected, installed, applied, or connected, used, cleaned and conditioned in accordance with the printed instructions and directions of the manufacturer.
- C. The installation shall be so made that its several component parts will function together as a workable system. It shall be complete with all accessories necessary for its operation and shall be left with all equipment properly adjusted and in working order.
- D. The work shall be executed in conformity with the best practice and so as to contribute to efficiency of operation, minimum maintenance, accessibility and sightliness. It shall also be executed so that the installation will conform and accommodate itself to the building structure, its equipment and usage.
- E. Whenever in the contract documents a particular brand, make of material, device or equipment is shown or specified, such brand, make of material, device or equipment is to be regarded merely as a standard and such trade name shall be followed by "or equal".

1.2 QUALITY ASSURANCE

- A. The equipment and materials to be furnished under this Contract shall be the products of well established and reliable firms which have had ample experience for at least five (5) years in the manufacture of equipment or materials similar in design and of equal quality to that specified. If required, the manufacturer shall submit a list of installations of similar equipment which have been in successful operation for at least five (5) years.

1.3 EXPERIENCE CLAUSE REQUIREMENT AND PERFORMANCE BONDS FOR MANUFACTURER

- A. For every piece of equipment furnished under this Contract, the manufacturer will be required to have a minimum of five (5) years of experience in providing this specific type of equipment. In lieu of this experience requirement, the manufacturer will be required to provide performance bond(s) for the faithful performance of the equipment and guarantee payment in a sum of not less than one hundred and fifty percent (150%) of the total equipment price for the completed work for that item. In the absence of verifiable experience, the manufacturer will be required to provide the performance bond(s) for the same number of years that the manufacturer was found lacking in experience from the specified five (5) year period. The performance bond(s) shall be from an approved surety company, to the satisfaction of the Owner's Law Director.
- B. Agents of bonding companies which write bonds for the performance and payment of the contract shall furnish power of attorney bearing the seal of the company, evidencing such agent's authority to execute the particular type of bond to be furnished, and evidencing also the right of the surety company to do business in the State of Ohio. Copy of this proof shall be attached to each copy of the contract.
- C. The bond shall be purchased through a surety company with a local agent upon whom service of process can be made.
- D. In event of failure of surety or co-surety, the manufacturer shall immediately furnish a new bond, as required herein. The manufacturer's bond will not be released until all provisions of the contract have been fulfilled.
- E. The surety used for the bid bond and performance bond shall be listed in the latest U.S. Treasury Circular 570 and the Penal Sums shall be within the maximum specified for such company in said Circular 570.

END OF SECTION 013326

SECTION 013326.01 - QUALITY CONTROL PLAN

PART 1 - GENERAL

1.1 QUALITY CONTROL

- A. The Contractor shall be responsible for the quality of all materials incorporated into the project work and shall be responsible for all costs of testing and certification of same. The Contractor shall provide the City Engineer a list of three (3) local qualified firms for the City to select from to be the Contractor's testing firm.
- B. The Contractor shall provide the Engineer with a Quality Control Plan in which his testing methods/procedures are defined. Said Plan shall meet with the approval of the Engineer and include identification of laboratories, types of testing, and the tentative amount and scheduling of each.

All certifications of tests and/or gradations for materials to be utilized in the work and all quality control testing shall be performed by an independent laboratory (not affiliated with, owned by, or managed by the Contractor). The laboratory shall be accredited by the AASHTO Materials Reference Laboratory for the type of testing performed.

- C. The Owner may perform field Quality Assurance testing; however, such testing shall not relieve the Contractor from the responsibility of Quality Control testing or from supplying certificates from manufacturers or suppliers to demonstrate compliance with the specifications. It is intended that the testing by the Contractor and the Owner be complimentary toward a quality project; however, the Contractor may not assume the Owner will test or that any tests will be done in lieu of the Contractor's own Quality Control testing. In the same sense, the Contractor may not rely on Owner Quality Assurance testing as a basis of acceptance or approval of his work nor may any Owner performed testing be reflected in his submitted plan.

1.2 TEST CRITERIA

- A. The following tests at a minimum shall be included with the Contractor's Quality Control Plan in accordance with the specifications:
 - 1. Aggregates
 - a. For each material and/or different source, the laboratory shall perform soundness, gradation, and other tests for all parameters specified. Aggregates incorporated into concrete or asphalt mixes shall also be tested for moisture content daily.
 - 2. Compaction Tests
 - a. Compaction tests or field density tests shall be taken on all embankment, trench backfill, subgrade, and subbase materials.
 - b. Minimum testing shall be as follows:
 - Embankment testing shall be at least one (1) test/5000 S.F. of each lift;
 - Trench backfill testing shall be at least one (1) test/50 L.F. of each lift;

Subgrade and/or subbase testing shall be at least one (1) test/200 L.F. of pavement or /5000 S.F. of slabs; subject to greater frequency due to soil conditions or Engineer's direction.

- c. Proctors or relative density tests shall be performed as often as necessary for the differing soils or granular materials utilized. Proctors shall be run with a minimum of 5 points. Test reports shall show the wet (bulk) weight, dry weight, wet (bulk) density, dry density, moisture content weight and moisture content percentage. Both the dry curve and the wet curve shall be plotted. The source materials shall be tested for gradation, Atterberg limits, shore-hydrometer and moisture content.
3. Concrete Mix Design
 - a. For each type of concrete, the laboratory shall perform the necessary mix design providing all test data as required by the specifications.
 4. Concrete Field and Laboratory Tests
 - a. The laboratory shall cast concrete cylinders and test beams:
 - 1) One set of four cylinders per 50 C.Y. with a minimum of two sets per day. The cylinders shall be broken: one at 7 days, two at 28 days, one at 56 days, unless otherwise directed by the Engineer.
 - 2) One beam per 50 C.Y. with a minimum of two beams per day.
 - b. Temperature and unit weight shall be run on fresh concrete at intervals sufficient for the type of structure being placed and a minimum of once per day. Bulk weight, bucket weight, (tare), net weight, bucket factor (bucket volume) and unit weight shall be recorded on the fresh concrete report. Show all batch weights for yield calculations. Slump and air content tests shall be taken a minimum of one test per 20 C.Y. and at least once per day.
 - c. All field and laboratory testing shall be performed by technicians certified by the American Concrete Institute (ACI) for the type of testing performed.
 - d. Initial cure of all cylinders shall be in a temperature-controlled cure box or temperature controlled water tank with a hi-low thermometer. Hi-low temperature readings shall be recorded on the fresh concrete report.
 5. Asphalt Mix Design
 - a. For each type of asphalt mix, submit job mix formula (JMF) prepared by an ODOT pre-qualified laboratory from tests performed on the aggregates proposed for use.
 - b. Sample and test for gradation and bitumen content as per ODOT 441.
 - c. Asphalt compaction, thickness, and temperature tests shall be performed during asphalt placement per ODOT Item 448.

1.3 LABORATORY REPORTS

- A. Reports of laboratory and field tests will be distributed to the Engineer, Owner, and Suppliers within 24 hours of completion.

END OF SECTION 013326.01

SECTION 013516 - ALTERATION PROJECT PROCEDURES

PART 1 - GENERAL

1.1 SUMMARY

- A. Work in this Section applies solely to the renovation and improvements to the Administration/Operations Building (Building #1).
- B. Section includes special procedures for alteration work.

1.2 DEFINITIONS

- A. Alteration Work: This term includes remodeling, renovation, repair, and maintenance work performed within existing spaces or on existing surfaces as part of the Project.
- B. Dismantle: To remove by disassembling or detaching an item from a surface, using gentle methods and equipment to prevent damage to the item and surfaces; disposing of items unless indicated to be salvaged or reinstalled.
- C. Match: To blend with adjacent construction and manifest no apparent difference in material type, species, cut, form, detail, color, grain, texture, or finish; as approved by A/E.
- D. Repair: To correct damage and defects, retaining existing materials, features, and finishes. This includes patching, piecing-in, splicing, consolidating, or otherwise reinforcing or upgrading materials.
- E. Replace: To remove, duplicate, and reinstall entire item with new material. The original item is the pattern for creating duplicates unless otherwise indicated.
- F. Retain: To keep an element or detail secure and intact.
- G. Strip: To remove existing finish down to base material unless otherwise indicated.

1.3 COORDINATION

- A. Alteration Work Subschedule: A construction schedule coordinating the sequencing and scheduling of alteration work for entire Project, including each activity to be performed, and based on Contractor's Construction Schedule. Secure time commitments for performing critical construction activities from separate entities responsible for alteration work.
 - 1. Schedule construction operations in sequence required to obtain best Work results.
 - 2. Coordinate sequence of alteration work activities to accommodate the following:
 - a. Owner's continuing occupancy of portions of existing building.

- b. Owner's partial occupancy of completed Work.
 - c. Other known work in progress.
 - d. Tests and inspections.
 - 3. Detail sequence of alteration work, with start and end dates.
 - 4. Utility Services: Indicate how long utility services will be interrupted. Coordinate shutoff, capping, and continuation of utility services.
 - 5. Equipment Data: List gross loaded weight, axle-load distribution, and wheel-base dimension data for mobile and heavy equipment proposed for use in existing structure. Do not use such equipment without certification from Contractor's professional engineer that the structure can support the imposed loadings without damage.
- B. Pedestrian and Vehicular Circulation: Coordinate alteration work with circulation patterns within Project building(s) and site. Some work is near circulation patterns. Circulation patterns cannot be closed off entirely and in places can be only temporarily redirected around small areas of work. Plan and execute the Work accordingly.

1.4 PROJECT MEETINGS FOR ALTERATION WORK

- A. Preliminary Conference for Alteration Work: Before starting alteration work, conduct conference at Project site.
- 1. Attendees: In addition to representatives of Owner, A/E, and Contractor, and specialists shall be represented at the meeting.
 - 2. Agenda: Discuss items of significance that could affect progress of alteration work, including review of the following:
 - a. Alteration Work Subschedule: Discuss and finalize; verify availability of materials, specialists' personnel, equipment, and facilities needed to make progress and avoid delays.
 - b. Fire-prevention plan.
 - c. Governing regulations.
 - d. Areas where existing construction is to remain and the required protection.
 - e. Hauling routes.
 - f. Sequence of alteration work operations.
 - g. Storage, protection, and accounting for salvaged and specially fabricated items.
 - h. Existing conditions, staging, and structural loading limitations of areas where materials are stored.
 - i. Requirements for extent and quality of work, tolerances, and required clearances.
 - 3. Reporting: Record conference results and distribute copies to everyone in attendance and to others affected by decisions or actions resulting from conference.

1.5 MATERIALS OWNERSHIP

- A. Historic items, relics, and similar objects including, but not limited to, cornerstones and their contents, commemorative plaques and tablets, antiques, and other items of interest or value to Owner that may be encountered or uncovered during the Work, regardless of whether they were previously documented, remain Owner's property.
 - 1. Carefully dismantle and salvage each item or object in a manner to prevent damage and protect it from damage, then promptly deliver it to Owner where directed at Project site.

1.6 INFORMATIONAL SUBMITTALS

- A. Alteration Work Subschedule:
 - 1. Submit alteration work subschedule within seven days of date established for commencement of alteration work.

1.7 QUALITY ASSURANCE

- A. Alteration Work Program: Prepare a written plan for alteration work for whole Project, including each phase or process and protection of surrounding materials during operations. Show compliance with indicated methods and procedures specified in this and other Sections. Coordinate this whole-Project alteration work program with specific requirements of programs required in other alteration work Sections.
 - 1. Dust and Noise Control: Include locations of proposed temporary dust- and noise-control partitions and means of egress from occupied areas coordinated with continuing on-site operations and other known work in progress.
 - 2. Debris Hauling: Include plans clearly marked to show debris hauling routes, turning radii, and locations and details of temporary protective barriers.
- B. Safety and Health Standard: Comply with ANSI/ASSP A10.6.

1.8 STORAGE AND HANDLING OF SALVAGED MATERIALS

- A. Salvaged Materials for Reinstallation:
 - 1. Repair and clean items for reuse as indicated.
 - 2. Pack or crate items after cleaning and repairing; cushion against damage during handling. Label contents of containers.
 - 3. Protect items from damage during transport and storage.
 - 4. Reinstall items in locations indicated. Comply with installation requirements for new materials and equipment unless otherwise indicated. Provide connections, supports, and miscellaneous materials to make items functional for use indicated.
- B. Existing Materials to Remain: Protect construction indicated to remain against damage and soiling from construction work. Where permitted by A/E, items may be dismantled and taken to a suitable, protected storage location during construction work and

reinstalled in their original locations after alteration and other construction work in the vicinity is complete.

- C. Storage: Catalog and store items within a weathertight enclosure where they are protected from moisture, weather, condensation, and freezing temperatures.
 - 1. Identify each item for reinstallation with a nonpermanent mark to document its original location. Indicate original locations on plans, elevations, sections, or photographs by annotating the identifying marks.
 - 2. Secure stored materials to protect from theft.
 - 3. Control humidity so that it does not exceed 85 percent. Maintain temperatures 5 deg F or more above the dew point.

- D. Storage Space:
 - 1. Owner will arrange for limited on-site location(s) for free storage of salvaged material. This storage space does not include security for stored material.
 - 2. Arrange for off-site locations for storage and protection of salvaged material that cannot be stored and protected on-site.

1.9 FIELD CONDITIONS

- A. Survey of Existing Conditions: Record existing conditions that affect the Work by use of preconstruction photographs.

- B. Discrepancies: Notify A/E of discrepancies between existing conditions and Drawings before proceeding with removal and dismantling work.

PART 2 - PRODUCTS - (Not Used)

PART 3 - EXECUTION

3.1 PROTECTION

- A. Protect persons, motor vehicles, surrounding surfaces of building, building site, plants, and surrounding buildings from harm resulting from alteration work.
 - 1. Use only proven protection methods, appropriate to each area and surface being protected.
 - 2. Erect temporary barriers to form and maintain fire-egress routes.
 - 3. Erect temporary protective covers over walkways and at points of pedestrian entrance and exit that must remain in service during alteration work.
 - 4. Contain dust and debris generated by alteration work and prevent it from reaching the public or adjacent surfaces.
 - 5. Provide shoring, bracing, and supports as necessary. Do not overload structural elements.
 - 6. Protect floors and other surfaces along hauling routes from damage, wear, and staining.

- B. Temporary Protection of Materials to Remain:
 - 1. Protect existing materials with temporary protections and construction. Do not remove existing materials unless otherwise indicated.
 - 2. Do not attach temporary protection to existing surfaces except as indicated as part of the alteration work program.
- C. Comply with each product manufacturer's written instructions for protections and precautions. Protect against adverse effects of products and procedures on people and adjacent materials, components, and vegetation.
- D. Utility and Communications Services:
 - 1. Notify Owner, A/E, authorities having jurisdiction, and entities owning or controlling wires, conduits, pipes, and other services affected by alteration work before commencing operations.
 - 2. Disconnect and cap pipes and services as required by authorities having jurisdiction, as required for alteration work.
 - 3. Maintain existing services unless otherwise indicated; keep in service and protect against damage during operations. Provide temporary services during interruptions to existing utilities.
- E. Existing Drains: Prior to the start of work in an area, test drainage system to ensure that it is functioning properly. Notify A/E immediately of inadequate drainage or blockage. Do not begin work in an area until the drainage system is functioning properly.
 - 1. Prevent solids such as adhesive or mortar residue or other debris from entering the drainage system. Clean out drains and drain lines that become sluggish or blocked by sand or other materials resulting from alteration work.
 - 2. Protect drains from pollutants. Block drains or filter out sediments, allowing only clean water to pass.

3.2 PROTECTION FROM FIRE

- A. General: Follow fire-prevention plan and the following:
 - 1. Comply with NFPA 241 requirements unless otherwise indicated.
 - 2. Remove and keep area free of combustibles, including rubbish, paper, waste, and chemicals, unless necessary for the immediate work.
 - a. If combustible material cannot be removed, provide fire blankets to cover such materials.
- B. Fire-Control Devices: Provide and maintain fire extinguishers, fire blankets, and rag buckets for disposal of rags with combustible liquids. Maintain each as suitable for the type of fire risk in each work area. Ensure that nearby personnel and the fire-watch personnel are trained in fire-extinguisher and blanket use.

3.3 GENERAL ALTERATION WORK

- A. Have specialty work performed only by qualified specialists.
- B. Ensure that supervisory personnel are present when work begins and during its progress.
- C. Record existing work before each procedure (preconstruction), and record progress during the work. Use digital preconstruction documentation photographs or video recordings.
- D. Perform surveys of Project site as the Work progresses to detect hazards resulting from alterations.
- E. Notify A/E of visible changes in the integrity of material or components whether from environmental causes including biological attack, UV degradation, freezing, or thawing or from structural defects including cracks, movement, or distortion.
 - 1. Do not proceed with the work in question until directed by A/E.

END OF SECTION 013516

SECTION 013543 - ENVIRONMENTAL PROTECTION

PART 1 - GENERAL

1.1 UNNECESSARY NOISE, DUST AND ODORS

- A. The Contractor's performance of this contract shall be conducted so as to eliminate all unnecessary noise, dust and odors.

1.2 SEWAGE, SURFACE AND FLOOD FLOWS

- A. The Contractor shall take whatever action is necessary to provide all necessary tools, equipment and machinery to adequately handle all sewage, surface flows and flood flows which may be encountered during the performance of the work. The entire cost of and liability for handling such flows is the responsibility of the Contractor and shall be included in the price for the appropriate item.

1.3 WORK IN FREEZING WEATHER

- A. Written permission from the Engineer shall be obtained before any work is performed which, in the judgment of the Engineer, may be affected by frost, cold, or snow. When work is performed under such conditions, the Contractor shall provide facilities for heating the materials and for protecting the finished work.

1.4 POLLUTION CONTROL

- A. It shall be the responsibility of the Contractor to prevent or limit pollution of air and water resulting from his operations.
- B. The Contractor shall perform work required to prevent soil from eroding or otherwise entering onto all paved areas and into natural watercourses, ditches, and public sewer systems. This work shall conform to all local ordinances and/or regulations, if any, and if not otherwise regulated by local ordinances or regulations shall at a minimum conform to the Ohio EPA General Storm Water NPDES Permit for Construction Activities and the Ohio Department of Natural Resources Rainwater and Land Development manual. This work may consist of but not be limited to construction and continual maintenance of silt fence, bio bag filters, sedimentation traps, stilling basins, check dams, temporary seeding, temporary mulching, erosion mats and other means to clarify waters containing suspended materials from excavations, embankments, cleared and grubbed or stripped areas, stockpiles, well points, and disposal sites and shall be commensurate with the contractor's schedule, sequence of work, means and methods. If a SWPPP plan is not required for the project, the contractor shall at a minimum submit a plan of his proposed erosion control prevention methods for approval by the Owner and/or other regulatory authorities having jurisdiction prior to starting any construction activities which may cause erosion.

- C. The Contractor shall perform work required to prevent dust attributable to his operations from entering the atmosphere. Dust on unsurfaced streets or parking areas and any remaining dust on surfaced streets shall be controlled with water and/or calcium chloride dust palliative as needed.
- D. Any material removed from sanitary or storm sewers shall be disposed in accordance with all applicable regulations.

END OF SECTION 013543

SECTION 014223 - INDUSTRY STANDARDS

PART 1 - GENERAL

1.1 ABBREVIATIONS

A. Abbreviations, as used, designate the following:

AASHTO	-	American Association of State Highway and Transportation Officials
ACI	-	American Concrete Institute
AIEE	-	American Institute of Electrical Engineers
AISC	-	American Institute of Steel Construction
ANSI	-	American National Standards Institute
ASTM	-	American Society of Testing and Materials
AWWA	-	American Water Works Association
CMS	-	Construction and Material Specifications
NEMA	-	National Electrical Manufacturers Association
ODOT	-	Ohio Department of Transportation
ORC	-	Ohio Revised Code
UL	-	Underwriters Laboratories, Inc.

1.2 REFERENCE TO OTHER SPECIFICATIONS

- A. Where reference is made to specifications such as ASTM, AWWA or AASHTO, the latest edition shall be used, unless otherwise noted on the plans or in the specifications.

1.3 CODES AND STANDARDS

- A. All work provided for by these specifications must be installed according to the provisions of the State and local building codes, subject to inspection and acceptance by the State and local inspectors.

END OF SECTION 014223

SECTION 014323 – QUALIFICATIONS OF TRADESMEN

PART 1 - GENERAL

1.1 CHARACTER OF WORKMEN AND EQUIPMENT

- A. The Contractor shall employ competent and efficient workmen for every kind of work. Any person employed on the work who shall refuse or neglect to obey directions of the Engineer or his representative, or who shall be deemed incompetent or disorderly, or who shall commit trespass upon public or private property in the vicinity of the work, shall be dismissed when the Engineer so orders, and shall not be re-employed unless express permission be given by the Engineer. The methods, equipment and appliances used on the work and the labor employed shall be such as will produce a satisfactory quality of work, and shall be adequate to complete the contract within the specified time limit.

- B. In hiring of employees for the performance of work under this Contract, or any Subcontract hereunder, no Contractor or Subcontractor, nor any person acting on behalf of such Contractor or Subcontractor, shall, by reason of race, sex, creed or color, discriminate against any citizen of the State of Ohio in the work to which the employment relates. No Contractor, Subcontractor, nor any person on his behalf shall, in any manner, discriminate against or intimidate any employee hired for the performance of work under this contract on account of race, creed, sex or color.

END OF SECTION 014323

SECTION 014523 – TESTING, ADJUSTING AND BALANCING

PART 1 - GENERAL

1.1 GENERAL DESCRIPTION

- A. This Section includes general requirements for the conduct of testing, adjusting and balancing.

1.2 SUMMARY

- B. Testing, adjusting and balancing shall be performed in accordance with recognized industry standards and as specified in the Contract Documents.

1.3 RELATED DOCUMENTS

- A. Section 013323 – Shop Drawings, Product Data and Submittals
- B. Section 017517 – Starting of Systems / Commissioning

1.4 DEFINITIONS

- A. Dry Testing:
 - 1. Dry Testing is performed by the Contractor without introducing either process material or other test material into the component, system, or unit process.
- B. Wet Testing:
 - 1. Wet Testing is performed by the contractor utilizing test material in the component, system, or unit process. Process Tankage shall be filled with test material to operating level.
- C. Performance Testing:
 - 1. Performance Testing is performed by the Contractor to demonstrate system performance in accordance with Contract Document requirements.
- D. Factory Testing:
 - 1. Factory Testing is performance testing, operation testing, or documentation verification conducted in the production facilities, or specialized test facilities, of the equipment supplier. Such testing shall conform to the requirements of individual sections of the Contract Documents.
- E. Field Testing:
 - 1. Field testing is performance testing, operation testing, or documentation verification conducted in the field after installation, to provide comparison with the results obtained in the factory testing. All field testing shall be witnessed by the Contractor.

1.5 SUBMITTALS

A. Quality Control Submittals:

1. Test Reports shall be submitted to the Contractor within 48 hours of the completion, suspension, or termination of the test unless otherwise approved by the Contractor. Submit Test Reports per Section 013323 – Shop Drawings, Product Data and Submittals

B. Project Record Documents:

1. Test, adjustment and balancing data shall be recorded by the Contractor per the Specifications.

1.6 REGULATORY REQUIREMENTS

- ### A.
- The requirements of this Section are in addition to those specifications by Regulatory Agencies. Except as specification prohibited or modified by the Specifications, comply fully with all requirements of this Section.

PART 2 - PRODUCTS

2.1 MATERIALS AND EQUIPMENT

- ### A.
- The Contractor shall supply all materials and equipment used in testing, adjusting and balancing.
- ### B.
- Materials and equipment used shall be of good quality and suitable for the intended service. The use of miscellaneous items found at the job site is not acceptable.
- ### C.
- Select capacity or range of test equipment to provide meaningful test results. Select pressure or differential pressure gauges so that test pressure is 50% to 75% of the gauge capacity.

2.2 FABRICATION

- ### A.
- The Contractor shall fabricate temporary equipment used in testing.

2.3 SOURCE QUALITY CONTROL

- ### A.
- All test instruments shall be calibrated to recognized standards, traceable to NBS standards, by the instrument manufacturer or a qualified independent calibration laboratory. Submit instrument calibration data for the Contractor's review prior to the test.

PART 3 - EXECUTION

3.1 EXAMINATION AND VERIFICATION OF CONDITION

- ### A.
- Verify the equipment, component, or system is completely and correctly installed before beginning tests.

- B. Review the design and installation of the system or equipment to ensure that the proposed test will not result in a hazard to personnel or equipment.

3.2 PREPARATION

- A. Design, fabricate, and install test equipment before commencing the test.
- B. Where required by the Contract Documents, or when required by the Contractor, an approved representative of the manufacturer shall be on site to provide technical direction.
- C. Notify and obtain approval of the Contractor not less than 72 hours prior to each test. See Section 017517, Starting of Systems/Commissioning.

3.3 TESTING, ADJUSTING, AND BALANCING

- A. Dry Testing:
 - 1. All equipment and systems shall be tested, adjusted, aligned, lubricate, and balanced in accordance with the manufacturer's instructions prior to witnesses testing.
 - 2. Test individual components prior to testing the system of which they are a part.
- B. Wet Testing:
 - 1. Test all equipment and systems with a test material, such as potable water or plant treated effluent water. All costs, including materials and equipment, for delivery of the test material shall be at the Contractor's expense. Any cost to the Owner for test material shall be back charged to the Contractor. Test materials obtained from the Owner are not guaranteed as to their pressure, quality or quantity available. Test each component or item of equipment to demonstrate compliance with the design criteria or range of criteria.
 - 2. After testing, adjusting, and balancing, test all equipment and systems for a minimum of 72 hours under the design operating conditions utilizing test material.
 - 3. Suspend or secure all tests in the event of test failures, or if hazardous conditions occur. Make repairs, replacements, or adjustments and re-start test in its entirety.
 - 4. The Contractor will dispose of the test material to the approval of the Owner at no additional expense to the Owner.
 - 5. The Contractor shall clean all equipment systems and structures upon conclusion of testing, unless otherwise directed by the Owner, at no additional expense to the Owner.
- C. Factory Testing
 - 1. Conform to the specific test requirements, as given in individual sections of the Project Manual.
 - 2. If equipment or materials fail or if testing must be extended beyond the original approved duration due to additional testing required as a result of the appearance of defect in the work or if testing could not be completed or conducted as outlined in the approved schedule, the cost of such re-testing, including additional or extended conveyance and maintenance of the Owner shall be borne by the Contractor.

3. Delays to the Contractor's Detailed Construction Network as specified in the Contractor's Progress Schedule due to failed, delayed or extended testing and the need for subsequent re-testing shall not entitle the Contractor to an extension of the contract time or additional cost. If the scheduling of the re-testing causes any activities shown on the Contractor's Detailed construction network to fall behind schedule to the extent that specific milestones or completion dates are in jeopardy, the Contractor shall prepare a recovery schedule and submit such to the Owner prior to the re-testing of the equipment.

D. Field Testing

1. Conform to the specific test requirements as given in individual sections of the Project Manual. Provide all necessary assistance to Owner personnel, at no additional cost to the Owner. All field testing shall be witnessed by the Owner.

3.4 FIELD QUALITY CONTROL

- A. Submit Test Reports for all tests, successful or unsuccessful in accordance with Section 013323 – Shop Drawings, Product Data and Submittals.
- B. Test shall be repeated per the General Conditions if results of testing fail to meet test criteria, whether the failure is identified in the field at the time of testing or through Test Report review.

END OF SECTION 014523

SECTION 015100 - TEMPORARY POWER SERVICE

PART 1 - GENERAL

1.1 ELECTRICAL POWER

- A. The Contractor shall furnish at his own expense all electrical power which may be required for the project. All temporary lines shall be furnished and installed by the Contractor at his own expense in a manner which meets the approval of the Engineer, and shall be removed by the Contractor at the completion of the construction.

END OF SECTION 015100

SECTION 015213 - FIELD OFFICES

PART 1 - GENERAL

1.1 CONTRACTOR'S OFFICE

- A. Each Contractor shall provide and maintain an office on the site of the work during the construction period of the contract, at which he or his authorized agent shall be present at all times while the work is in progress.

1.2 RESIDENT ENGINEER'S OFFICE

- A. The General Construction Contractor shall be required to provide and maintain the herein described Resident Engineer's office, services and office equipment until completion of the contract including punch list. All equipment shall be provided with a maintenance contract which provides prompt service. During anytime a service or equipment is non-operative, the Resident Engineer may utilize a commercial service or rental equipment at the Contractor's expense until the service or equipment is restored.
- B. The Electrical Contractor shall provide and install temporary power, internet access and telephone lines to the Engineer's office.
- C. Office Equipment
 1. One (1) Desk with Desk Chair
 2. One (1) Plan Racks
 3. One (1) Plan Tables
 4. One (1) Conference Table (Approximately 3' x 6')
 5. Eight (8) Chairs for Conference Table
 6. The drafting table and drafting stool are required
 7. Two (2) Four-Drawer Letter Size Lockable Filing Cabinets
 8. One (1) Bookcase (36" x 30" x 10" each)
 9. Four (4) Wastepaper Baskets
 10. One (1) Two-Drawer Letter Size Lockable Filing Cabinet
 11. A printer, copier, scanner is required. Hardware, services and maintenance of a printer, scanner and copier with collator and automatic feeder in the Resident Engineer's office. The copier shall be a plain paper copier, capable of making 8-1/2 by 11 inches and 11x17 inches size for size copies. Also included shall be an allowance for copy materials (including paper supply) in the amount of 2,000 copies per month.

1.3 AID TO THE INJURED

- A. The Contractor shall keep in his office and on the work site, all articles necessary for giving "First Aid to the Injured." He shall also have standing arrangements for the immediate removal and hospital treatment of any employee or other person who may be injured on the work site.

END OF SECTION 015213

SECTION 015526 - TEMPORARY TRAFFIC CONTROL DEVICES

PART 1 - GENERAL

1.1 BARRICADES, SIGNS AND LIGHTS

- A. The Contractor shall employ watchmen on the work when and as necessary. The Contractor shall erect and maintain such strong and suitable barriers and such lights as will effectively prevent the occurrence of any accident to health, limb or property. Lights shall be maintained between the hours of one-half (1/2) hour after sunset and one-half (1/2) hour before sunrise.
- B. No manhole, trench, excavation will be left open awaiting connection or removal at a later date by the Contractor's forces or others but shall be temporarily backfilled and resurfaced if applicable with a temporary pavement passable to traffic at no additional cost to the Owner.
- C. In addition to other safety requirements, a minimum of four (4) foot high fence will be incorporated around any shaft or manhole or other excavation left open at the end of a day's work.

1.2 MAINTENANCE OF TRAFFIC

- A. The Contractor is required to provide maintenance of traffic in conformance with the Ohio Manual of Uniform Traffic Control Devices and Item 614 of the current Construction and Material Specifications of the Ohio Department of Transportation.
- B. This work shall include providing suitable and satisfactorily trained and properly attired flagmen for use at any location where existing roadway is narrowed to a width of less than 2 full lanes (18 feet).
- C. The Contractor is also responsible for maintaining local access to all residences and businesses along the route of the construction and to provide whatever temporary materials are necessary to provide a safe, adequate drive surface.
- D. At all boring locations, Contractor shall provide suitable flashers, barricades, and traffic control devices as may be deemed necessary by the Engineer or the responsible authority in the case of the Department of Transportation, Turnpike Commission, or affected railroad. This may extend to maintain facilities on a 24-hour basis until such time as the areas are completely backfilled.

END OF SECTION 015526

SECTION 016600 - PRODUCT HANDLING AND PROTECTION

PART 1 - GENERAL

1.1 DELIVERY AND STORAGE OF MATERIALS

- A. The Contractor shall be responsible for delivery and storage of all materials.
- B. The Contractor shall coordinate with the Engineer on the arrangement for storing construction materials and equipment. Deliveries of all construction materials and equipment should be made at suitable times.
- C. The Contractor shall store all materials required for the performance of this contract at sites designated by the Engineer.
- D. All stockpiles shall be neat, compact, completely safe, and barricaded with warning lights if necessary.
- E. Precautions shall be taken so that no shade trees, shrubs, flowers, sidewalks, driveways or other facilities will be damaged by the storage of materials. The Contractor shall be responsible for the restoration of all stockpile sites to their original condition.
- F. Materials, tools and machinery shall not be piled or placed against shade trees, unless they shall be amply protected against injury therefrom. All materials, tools, machinery, etc. stored upon public thoroughfares must be provided with red lights at night time so as to warn the traffic of such obstruction.
- G. Materials shall be so stored as to assure the preservation of their quality and fitness for the work. Stored materials, even though approved before storage, shall again be inspected prior to their use in the work. Stored materials shall be located so as to facilitate their prompt inspection. Approved portions of the construction site may be used for storage purposes and for the placing of the Contractor's plant and equipment, but any additional space required therefore must be provided by the Contractor at his expense. Private property shall not be used for storage purposes without written permission of the property owner or lessee, and copies of such written permission shall be furnished the Engineer. All storage sites shall be restored to their original condition by the Contractor at his expense.

END OF SECTION 016600

SECTION 016617 - MAINTENANCE

PART 1 - GENERAL

1.1 DESCRIPTION

- A. This Section provides general requirements for the maintenance of equipment in the field. Storage maintenance requirements are provided by Section 016600, Product Handling and Protection. Specific maintenance requirements are provided by manufacturers per individual Sections in the Project Manual.
- B. Maintenance is performed to ensure delivery to the Owner of equipment in an undeteriorated and fully serviceable condition.
- C. This Section also includes requirements for preventive and corrective maintenance during operation of the equipment prior to the commencement of the Warranty period.

1.2 RELATED SECTIONS

- A. Section 016600, Product Handling and Protection.

1.3 DEFINITIONS

- A. Storage maintenance consists of establishing and maintaining the environment required by the stored materials and performing periodic servicing.
- B. Preventive maintenance consists of activities performed on a periodic basis to maintain operating or operational items or equipment.
- C. Corrective maintenance consists of correcting faults or failures in an item or equipment. This may include adjustments or replacement of defective parts.

1.4 SUBMITTALS

- A. The Maintenance Log shall be submitted to the Owner upon completion of the Operational Demonstration and before the start of the Warranty period.
- B. No submittals are required by this Section, except as noted above. Maintenance schedules and practices shall conform to approved submittals required by individual Sections in the Project Manual.

PART 2 – PRODUCTS

2.1 COMPONENTS, ACCESSORIES AND REPAIR PARTS

- A. All components, accessories and repair parts used in maintenance shall be supplied by or approved by the equipment manufacturer for use on the equipment.

2.2 SOURCE QUALITY CONTROL

- A. All parts and materials used in maintenance shall meet the quality control requirements provided for the item or equipment. These are specified in individual Sections of the Project Manual.

PART 3 – EXECUTION

3.1 EXAMINATION AND VERIFICATION OF CONDITION

- A. The Contractor shall prepare a Maintenance Log for all equipment.
 - 1. This log shall include a list of required maintenance services and inspections, as provided by the manufacturer and submitted under individual Sections of the Project Manual.
 - 2. The Maintenance Log shall include checklists for the periodic services and inspections required.
 - 3. The Contractor shall initial and date the requisite log entries upon completion of the individual servicing or inspection.
 - 4. The Maintenance Log shall be located in the Contractor's Field Office and shall be available for review by the Owner until it is submitted for record purposes upon completion of the Operational Demonstration and the start of the Warranty period.

3.2 PREPARATION

- A. Before removing an item from storage per Section 016600, the Contractor shall review the installed location. Protection and services at the installed location must meet the equipment storage requirements.
- B. Before moving equipment to the installed location, the Contractor shall have available materials for temporary shelter or services required to establish the proper storage environment after the equipment is installed until it is placed in service in its final operating environment.

3.3 PERFORMANCE OF MAINTENANCE

- A. The Contractor shall perform all storage and preventive maintenance and inspections required by the manufacturer at the specified intervals.

- B. When notified by the Owner, the Contractor will perform corrective maintenance. This will be performed at no cost to the Owner. Corrective maintenance will be performed per manufacturer's written instructions or by direction of the approved representative of the manufacturer.
- C. The Contractor shall restore equipment to its operating condition before start-up.
- D. The Contractor shall re-establish storage maintenance in the event an item or equipment is removed from service.
- E. When the equipment warranty becomes effective, the Owner will assume responsibility for its maintenance.

END OF SECTION 016617

SECTION 017517 - STARTING OF SYSTEMS/COMMISSIONING

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

- A. This Section includes general requirements for the commissioning of the Work and start-up and operation of systems and equipment.

1.2 SUMMARY

- A. Starting, testing, and operating the completed Work including systems and equipment until Substantial Completion is achieved and operation of the completed Work including systems or equipment are accepted by the Owner. Contractor shall cooperate and coordinate with the Owner in the operation, maintenance, and adjustment of the Work.

1.3 RELATED SECTIONS

- A. Section 013323, Product Testing and Certifying
- B. Section 016617, Maintenance
- C. Section 017901, Operational Demonstration
- D. Section 017902, Instruction of Owner's Personnel

1.4 DEFINITIONS

- A. **Commissioning:** Commissioning is the series of activities, or process, necessary to ensure that systems and equipment are designed, installed, functionally tested, started up and capable of being operated and maintained to perform in conformity with the design intent for the facility improvements. Commissioning includes, but is not limited to factory testing, field testing, dry testing, wet testing, performance testing, manufacturer's checkout, start-up, and Operational Demonstration.
- B. **Factory Testing:** Factory Testing is performance testing, operation testing, or documentation verification conducted in the production facilities, or specialized test facilities, of the equipment supplier. Such testing shall conform to the requirements of the individual sections of the Contract Documents.

"Witnessed" Factory Testing shall mean that the testing is witnessed by the Owner or his designated representative.

- C. Field Testing: Field Testing is performance testing, operation testing, or documentation verification conducted in the field after installation, to provide comparison with the results obtained in the Factory Testing.
- D. Dry Testing: Dry Testing is performed by the Contractor without introducing either process material or other test material into the component, system, or unit process.
- E. Wet Testing: Wet Testing is testing performed by the Contractor utilizing test material in the component, system, or unit process. Tankage shall be filled with test material to operating level.
- F. Performance Testing: Performance Testing is performed by the Contractor to demonstrate system performance in accordance with the Project Manual requirements.
- G. Manufacturer's Check-Out: Field inspection, testing, adjustments, and sign off by the approved representative of the Manufacturer, indicating that the component, system, or unit process meets the manufacturer's requirements.
- H. Start-Up: Narrowly defined as placing a component, system, or unit process on-line. Start-up can be a commissioning activity or a normal operating activity.
- I. Operational Demonstration: A commissioning activity performed by the Contractor wherein the Contractor operates and maintains a fully functional component, system, or unit process for a period of time after stable operation has been achieved.

1.5 SUBMITTALS

- A. Quality Control Submittals:
 - 1. Field Installation Reports – Submit reports by Manufacturer's Representative in accordance with Paragraph 3.4 of this Section.
- B. Commissioning Documentation: Contractor shall prepare and submit all documentation for review and approval. The documentation shall include, but not be limited to, the following:
 - 1. Certification by the preparer that he/she is the person responsible for the data, and that the data is authentic and accurate.
 - 2. Certification by the Contractor or equipment or unit process systems supplier that the equipment or the unit process systems were operated continuously for the specified period and that the equipment or unit process systems operated in compliance with the specified operating conditions,

parameters and performance: and that the equipment or unit process systems are suitable for Performance Testing.

3. Pertinent background information shall include, but not be limited to, the following:
 - a. Equipment or unit process systems Started-Up and Commissioned
 - b. Start-Up and Commissioning dates
 - c. Items or performance criteria tested clearly showing requirements and field data that verify requirements were met.
 - d. Names of witnesses for Start-Up and Commissioning.
 - e. Any repairs, corrections, or modifications required for the equipment or unit process systems to successfully complete Start-Up and Commissioning.
 - f. Loop diagrams accurately depicting the installed condition of instrumentation and controls.
 - g. Any other important background information.

4. Appendix
 - a. A summary of all data used in the calculation, including source, formulas with all terms defined.
 - b. Calculations for all data submitted, fully defined.
 - c. Copies of all raw field data sheets, including those indicating sampling point locations, and notes.
 - d. Production and/or operational data.
 - e. Calibration procedures and worksheets for sampling equipment.
 - f. Copies of calibration records for instrumentation.
 - g. PLC Ladder logic documented with comments.

PART 2 – PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 EXAMINATION AND VERIFICATION OF CONDITION

- A. The Contractor shall inspect systems and equipment prior to each start-up and verify their readiness for start-up. Conditions hazardous to equipment or personnel shall be corrected by the Contractor prior to start-up of equipment.
 1. Start-up operations shall not proceed using temporary power or temporary instrumentation and control wiring. All electrical and control connections shall be permanent and complete, and all such electrical components and equipment fully functional.
 2. Use of repair parts during start-up operations shall not be permitted, except in such situations where the actual on-site verification of such repair parts' operability is specified.

3. The Contractor shall verify that all initial copies of the Maintenance and Operating Instructions have received an acceptable disposition as defined in Section 013323, and the only outstanding item is the field verification of the Instructions.
- B. On successful completion of Start-up, process flows and solids shall be used for commissioning the equipment and unit process systems to show the equipment and unit process systems function properly. Commissioning shall confirm the proper operation of the equipment and unit process systems with process fluids and process solids, adjustment shall be made, and the equipment or unit process systems shall be optimized and brought into compliance with design criteria in preparation for Operational Demonstration.
 - C. The Contractor shall coordinate all Start-up and Commissioning activities for equipment and unit processes. The Contractor shall develop a detailed start-up and commissioning plan that includes the following as a minimum:
 1. Description of the overall general start-up and commissioning process.
 2. List of equipment and unit process systems included for start-up and commissioning activities.
 3. Detailed start-up and commissioning sequence of activities.
 4. Listing of staff and responsibilities for activities.
 5. Contractor shall use a form that will be provided by the Owner.

3.2 PREPARATION

- A. Prior to start-up of equipment or systems, all necessary test equipment shall be in place and operable.
- B. Approved representative(s) of the Manufacturer and Contractor shall be present for the initial start-up of systems or equipment.
- C. The Contractor shall request permission to start-up equipment, including electrical gear, and notify the Owner using a standard Start-Up Request form.
 1. The Start-Up Request shall be submitted to the Owner a minimum of 72 hours before the scheduled start-up. Requests shall be made during normal working hours.
 2. The Contractor shall provide all information in the first Section of the Start-Up Request form.
 3. The Owner will indicate approval or disapproval of the request.
 4. Approval of the request is based solely on impact on plant operations. Approval does not relieve the Contractor of any responsibility for plant and personnel safety.

5. The Contractor shall obtain the approved Start-Up Request prior to the system or equipment start-up.
 6. If training is to be conducted in conjunction with the start-up this should be indicated on the Start-Up Request form. All requirements of Section 019215, Instruction of Owner's Personnel must be met for training sessions.
 7. Start-ups performed at the direction of the Contractor, per paragraph 3.3(G) of this Section, do not require advance notification to the Engineer.
- D. Normal installation checks, such as for rotation, are not considered start-ups and do not normally require start-up notification. For all equipment and systems so designated in the Contract Documents, or so designated by the Engineer, such checks shall be under the supervision of the approved representative of the manufacturer, and shall be reviewed by the Engineer.
1. All electrical apparatus which is energized shall be clearly marked.

3.3 CONDUCT OF START-UP AND COMMISSIONING

A. Start-up:

1. All initial start-ups of equipment or systems shall be performed under the technical direction of the approved representative of the manufacturer.
 2. Any lack of readiness of associated systems or failure of a system or equipment previously started prior to the date of Final Completion of the Project shall require additional initial start-up service to be performed, under the direction of the approved representative of the manufacturer.
 3. The Contractor shall repair, replace or modify any equipment or system which fails to perform as specified in the Contract Documents. Such repair, replacement or modification of deficient work shall be performed under the terms of the General Conditions.
 4. During the Operational Demonstration period per Section 019214, Operational Demonstration and at other times when the system is on-line and an integral part of the Wastewater Treatment Plant operations and process, start-ups shall be performed as required by the Contractor.
- B. The Contractor shall be responsible for commissioning all work. Final acceptance shall be by the Owner.
- C. The Contractor is responsible for the performance and operation of the systems and equipment during commissioning.

- D. When Owner personnel are operating systems or equipment, the Contractor shall make available, at all times, persons knowledgeable about the systems or equipment to direct the Owner personnel in its operation.
- E. The Contractor shall make all adjustments and corrections necessary to achieve normal, stable operation of systems. Adjustment and corrections shall be in accordance with Section 016617, Maintenance.
- F. Any failures of equipment or systems operated under the direction of the Contractor shall be considered deficiencies and shall be corrected in accordance with the General Conditions.
- G. During the Operational Demonstration period as defined in Section 019214, Operational Demonstration and at other times, the work will be on-line and an integral part of the Wastewater Treatment Plant operations and process. The Owner maintains control of Wastewater Treatment Plant operations and processes at all times. Therefore:
 - 1. The Contractor shall not commence, resume, terminate, or suspend the operations without the permission of the Owner and only in a sequence and manner suitable to the Owner.
 - 2. The Contractor shall immediately, on a 24-hour per day, 7-day per week basis, adjust or repair any malfunction in the work which in the opinion of the Owner jeopardizes or may jeopardize the proper operation of the Wastewater Treatment Plant.
 - 3. The Contractor shall not start-up, shut down, adjust, or otherwise alter the operation of any component, system, or unit process without the permission of the Owner except in the case of an emergency and in accordance with the General Conditions.

3.4 QUALITY CONTROL

- A. Reports of the Approved Representative of the Manufacturer:
 - 1. The approved representative of the manufacturer shall prepare a daily report on each site visit for each system or item of equipment inspected, adjusted, started-up, or worked on.
 - 2. The report shall state the purpose of the visit, the representative's observations and conclusions, and recommendations for further visits or action.
 - 3. The reports shall be submitted in accordance with Section 013323, Shop Drawings, Product Data and Samples within three (3) days of the visit.

END OF SECTION 017517

SECTION 017800 - FINAL COMPLIANCE AND SUBMITTALS

PART 1 - GENERAL

- 1.1 The following forms and related sign-offs shall be documented in accordance with provisions of the contract. These forms shall be completed by the Contractor and approved by the Owner before final retainer is approved for release. Forms for Items A to E will be attached to the Contractor's executed copy of the contract.
- A. Certificate of Substantial Completion (To be submitted at time of Substantial Completion).
 - B. Contractor's Certification of Completion.
 - C. Contractor's Affidavit of Prevailing Wage.
 - D. Consent of Surety Company for Final Payment.
 - E. Affidavit of Final Acceptance Date and Correction Period.
 - F. Before the OWNER will approve and accept the work and release the retainer, the CONTRACTOR will furnish the OWNER a written report indicating the resolution of any and all property damage claims filed with the CONTRACTOR by any party during the construction period. The information to be supplied shall include, but not be limited to, name of claimant, date filed with CONTRACTOR, name of insurance company and/or adjuster handling claim, how claim was resolved and if claim was not resolved for the full amount, a statement indicating the reason for such action.
 - G. DBE Subcontractor Participation Forms SR-EPA.7-8 (Applicable for WPCLF & WSRLA funded projects only).
 - H. CDBG Subcontractor List 017800 (Applicable for CDBG funded projects only).

END OF SECTION 017800

SECTION 017821 - CLEANING AND PROTECTION

PART 1 - GENERAL

1.1 GENERAL

- A. On or before the completion date for the work, the Contractor shall tear down and remove all temporary structures built by him, all construction plant used by him, and shall repair and replace all parts of existing embankments, fences or other structures which were removed or injured by his operations or by the employees of the Contractor. The Contractor shall thoroughly clean out all buildings, sewers, drains, pipes, manholes, inlets and miscellaneous and appurtenant structures, and shall remove all rubbish leaving the grounds in a neat and satisfactory condition.
- B. As circumstances require and when ordered by the Engineer, the Contractor shall clean the road, driveway, and/or sidewalk on which construction activity under this contract has resulted in dirt or any other foreign material being deposited with an automatic self-contained mechanical sweeper with integral water spray, vacuum and on-board or supplementary containment.
- C. Failure to comply with this requirement when ordered by the Engineer or his representative, may serve as cause for the Engineer to stop the work and to withhold any monies due the Contractor until such order has been complied with to the satisfaction of the Engineer.
- D. As the work progresses, and as may be directed, the Contractor shall remove from the site and dispose of debris and waste material resulting from his work. Particular attention shall be given to minimizing any fire and safety hazard from form materials or from other combustibles as may be used in connection with the work, which should be removed daily.
- E. The Contractor shall wash all windows and other glass surfaces, leaving all areas free from putty marks, paint, etc.
- F. During and after installation, the Contractor shall furnish and maintain satisfactory protection to all equipment against injury by weather, flooding or breakage thereby permitting all work to be left in a new condition at the completion of the contract.

END OF SECTION 017821

SECTION 017823 – MAINTENANCE MANUALS

PART 1 - GENERAL

1.1 OPERATION AND MAINTENANCE MANUALS

- A. Operation and maintenance information shall be submitted for all manufactured items, i.e., equipment, hardware, pumps, valves, motors, etc.
- B. This manual will either contain or make reference to all information that has been issued during the construction and start-up periods, as well as information necessary for the proper operation and maintenance of equipment.
- C. It shall be the responsibility of the Contractor who supplies such equipment to obtain from his vendors the required information and submit to the Engineer. This information will be accepted only if properly identified and only after it has been revised, where necessary, to conform to previous transmittals of the same material that have been "approved as noted" by the Engineer. All submittals shall be on 8-1/2" X 11" size paper or folded to that size.
- D. In general and where applicable, the information shall consist of, but not be limited to, six (6) sets of the following:
 - 1. Descriptive literature, bulletins or other data covering equipment or system.
 - 2. Complete list of equipment and appurtenances included with system, complete with manufacturer and model number.
 - 3. Utility requirements.
 - 4. General arrangement drawing.
 - 5. Sectional assembly.
 - 6. Dimension print.
 - 7. Materials of construction.
 - 8. Certified performance curve.
 - 9. Performance guarantee.
 - 10. Copy of Warranty bond and service contract as applicable
 - 11. Parts list.
 - 12. Recommended spare parts list with part and catalog number.
 - 13. Lubrication recommendations and instructions.
 - 14. Schematic wiring diagrams.
 - 15. Programmable Logic Controllers if as furnished under the contract. Submit complete programmable logic controller listing of all input/output address assignments, tag assignments, and pre-set constant values, with functional point descriptions.
 - 16. Schematic piping diagrams.
 - 17. Instrumentation data.
 - 18. Drive dimensions and data.
 - 19. Control data.
 - 20. Operating instructions.
 - 21. Maintenance instructions including troubleshooting guidelines and preventative maintenance instructions with task schedule.
 - 22. Required tools and equipment for operation and maintenance.
 - 23. Safety considerations for O & M procedures.

1.2 FORMAT OF ELECTRONIC COPIES

- A. Electronic Copies of Operation and Maintenance Manuals:
1. Each electronic copy shall include all information included in the corresponding printed copy.
 2. Submit each electronic copy on a separate portable USB "thumb drive", unless another electronic data transfer method or format is acceptable to ENGINEER.
 3. File Format:
 - a. Files shall be in "portable document format" (PDF). Files shall be electronically searchable.
 - b. Submit separate file for each separate document in the printed copy.
 - c. Within each file, provide bookmarks for the following:
 - 1) Each chapter and subsection listed in the corresponding printed copy document's table of contents.
 - 2) Each figure.
 - 3) Each table.
 - 4) Each appendix.
- B. Copies of Programming and Configuration Files:
1. Furnish on portable USB "thumb drive" copy of all software programming, such as programmable logic controller programs, prepared specifically for the Project. Third-party, licensed, commercially available software is excluded from requirements of this Article; submit copies of commercially-available, licensed, third-party software, where required, in accordance with the Contract Documents.
 2. Submit portable USB "thumb drive" copies of system configuration prepared specifically for the Project, such as plant monitoring system and SCADA display configurations.
 3. Submit programming and configuration files concurrently with electronic copies of operation and maintenance data.

END OF SECTION 017823

SECTION 017839 - PROJECT RECORDS, DRAWINGS

PART 1 - GENERAL

1.1 RECORD DRAWINGS

- A. The Contractor shall furnish an authentic set of marked-up drawings showing the installation insofar as the installation shall have differed from the Engineer's drawings. The drawings shall be delivered to the Engineer for making revisions to the original drawings immediately after final acceptance by the Owner.
- B. The Contractor shall furnish dimensioned drawings indicating locations of all underground mechanical and electrical facilities.

1.2 SERVICE CONNECTION RECORDS

- A. The Contractor shall record the location of all service and property connections, new or existing, made to utilities constructed under this contract. Such records shall be turned over to the Owner upon completion of the work. The cost of making such records shall be included in the various unit or lump sum prices stipulated for the various items of the work.
- B. The location of each sewer connection as measured along the sewer from the nearest downstream manhole and its description with respect to the sewer shall be recorded. The record shall include the depth of new stubs for future connections and the depth of existing connections as measured from the surface grade. Also, the use of any vertical riser pipe shall be noted.
- C. The location of each water connection as measured along the water line from the nearest fire hydrant.

END OF SECTION 017839

SECTION 017901 – OPERATIONAL DEMONSTRATION

PART 1 - GENERAL

1.1 GENERAL DESCRIPTION

- A. Work Included: A demonstration of the operation of all systems is required. This Operational Demonstration shall be conducted, coordinated and recorded by the Contractor in accordance with the requirements specified herein.

1.2 SUMMARY

- A. Section Includes:
 - 1. Requirements for the conduct and reporting of the Operational Demonstration. This work is additional to any other installation, shop and factory testing, field testing, dry testing, wet testing, performance testing, balancing, or adjustments required elsewhere in the Contract Documents.

1.3 RELATED SECTIONS

- A. Section 17517, Starting of Systems / Commissioning

1.4 DEFINITIONS

- A. Operational Demonstration is defined in Section 17517, Starting of Systems/Commissioning.
- B. Operational Demonstration Log: A chronological record of the status of the system and equipment during the Operational Demonstration. All changes in status or system parameters, adjustments, and results of tests shall be included. Entries shall be made, noting the date and time, at the occurrence of each event. Operational Demonstration Logs shall be on a form acceptable to the Owner.

1.5 SUBMITTALS

- A. Quality Control Submittals:
- B. Test Reports:
 - 1. Operational Demonstration log per subparagraph 3.4.A of this Section.
 - 2. Report of Operational Demonstration per subparagraph 3.4.B.2 of this Section.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 EXAMINATION AND VERIFICATION OF CONDITION

- A. Before beginning the Operational Demonstration, the Contractor shall verify that:
1. All required construction activities are completed, including any activities by any entity that would interrupt the normal operations of the system. Coordinate with the Owner to resolve such conflicts.
 2. Adequate parts and supplies for routine maintenance and replacement are on hand to support system operation through the demonstration period.
 3. Start-up of equipment and systems per Section 110801, Starting of Systems/Commissioning has been completed.
 4. All Repair Parts and Maintenance Materials have been delivered to the Owner.
 5. Certain Instruction of Operating Personnel (training) has been scheduled to take place during the Operational Demonstration where specified. All other training will occur within 45 days prior to initiation of Operational Demonstration. The training of Operations Personnel shall be scheduled to take place during the first half of the demonstration period, and the remaining training of Electrical, Instrumentation and Maintenance Personnel shall be scheduled to be complete before the end of the Operational Demonstration.
 - a. The field verification of the Initial Maintenance and Operating Inspections has been completed in accordance with the Specifications.

3.2 PREPARATION

- A. The Contractor shall provide two (2) representatives, a prime and an alternate, who will be responsible for the Operational Demonstration. These representatives will:
1. Demonstrate the operation of systems and equipment to the Owner's operating personnel.
 2. Direct maintenance and repair work, by either the Contractor or the approved representative of the manufacturer of the system components and equipment.
 3. Maintain a log of the Operational Demonstration, as described herein.
 4. Be available at all times during the Operational Demonstration to perform these duties.
- B. Submit start-up notification to the Owner per Section 110801, Starting of Systems/Commissioning.

3.3 OPERATIONAL DEMONSTRATION

- A. The Contractor shall perform an Operational Demonstration of the work. Unless otherwise specified, the Operational Demonstration shall be a continuous 30-day, (720 hours) period during which the work is operated and maintained in a continuously on-line, fully functional process status.
- B. The Operational Demonstration shall encompass the entire work, or the portion thereof designated for Substantial Completion.
- C. Filling, draining, heating or cooling to temperature, stabilizing, adjusting, or other start-up activity time shall not be counted as Operational Demonstration time.
- D. During the Operational Demonstration period, the Contractor shall provide 24-hour per day, 7 days per week on-site supervision, in addition to the requirements of supervision as stated in the

General Conditions. The Contractor shall provide labor and sufficient material to fully operate and maintain the work 24 hours per day, 7 days per week.

- E. When systems are on-line, conform to the requirements of Section 110801, Starting of Systems/Commissioning, and Paragraph 3.3(G) for alterations in the Wastewater Treatment Plant processes.
- F. During the first half of the Operational Demonstration of the system and equipment, Owner personnel will observe the Contractor's personnel operating systems and equipment. The Contractor shall cooperate with this familiarization process.
- G. After the first 15 days of Operational Demonstration of system and equipment, operation of equipment will be assumed by the Owner personnel, under the direction of the Contractor, as described in Section 110801, Starting of Systems/Commissioning.

The Owner remains in control of the plant processes per Section 110801, Starting of Systems/Commissioning. The Contractor shall provide technical direction in the operation of equipment and systems.

- H. Start-up and operation of the system and all associated equipment shall be in accordance with the Initial Maintenance and Operating Instructions which have received an acceptable disposition from the Owner. If deviations from these instructions are necessary, these shall be noted in the Operational Demonstration Log, and subsequently submitted as revisions to the Maintenance and Operating Instructions. During the period of time between the completion of the Operational Demonstration and the Date of substantial Completion, the system and equipment will be operated and maintained under the requirements of the second half of the Operational Demonstration. The Owner will not assume full responsibility for maintenance of the system and equipment until all conditions for Substantial Completion have been satisfied and both the Contractor and Owner have accepted the Certificate of Substantial Completion.
- I. All required maintenance and servicing prior to the Date of Substantial Completion shall be performed by the Contractor at the specified interval and as necessary. All maintenance and servicing shall be noted in the Operational Demonstration Log.
- J. All outages of equipment, system(s), or the plant should be noted in the Operational Demonstration Log. Plant outages are considered a part of normal plant operation and will not invalidate the Operational Demonstration. The Contractor is responsible for the safe and orderly shutdown and restart of equipment as necessary in the event of an outage. Outage time is not to be included in the Operational Demonstration period.
- K. The Contractor shall attend operational coordination meetings as called by the Owner to review operating conditions of equipment and systems.
- L. If, during the Operational Demonstration, any part of the work fails to fully conform to the requirements of the Contract Documents, the Operational Demonstration shall be considered to have failed, and the work shall not be considered to be Substantially Complete as defined in the General Conditions and the Owner shall so notify the Contractor in writing. If, during the Operational Demonstration, the provisions of the General Conditions are evoked to stop the work, the Operational Demonstration will also be considered to have failed.
- M. Upon failure of the Operational Demonstration, the Contractor shall promptly remedy any defects in the work and shall promptly reschedule and re-start the complete 30 day, (720 hours)

Operational Demonstration time period. No Operational Demonstration time will be considered to have accrued to any part of the work by reason of a failed Operational Demonstration.

- N. During the Operational Demonstration, the Owner may require or permit the Operational Demonstration to be suspended:
 - 1. As provided in the General Conditions.
- O. Upon the written request of the Contractor to correct or adjust the work when in the judgment of the Owner such required correction or adjustment is insufficient to deem the Operational Demonstration to have failed.
 - 1. If the Operational Demonstration is suspended for any reason except failure, Operational Demonstration time shall accrue to the work from the time of the beginning of the Operational Demonstration to the time of the suspension.

3.4 REPORTING

- A. Daily: Copy of the Operational demonstration Logs shall be submitted to the Owner by 9:00 a.m. the following day.
- B. Within two (2) weeks of the termination or completion of the Operational Demonstration, the Contractor shall submit for approval:
 - 1. Any changes to the Maintenance and Operating Instructions.
 - 2. A report of the Operational Demonstration, describing the equipment utilized and any repairs, modifications, adjustments, or other work performed during the demonstration period.
- C. In the event the conduct of the Operational Demonstration or the submittals are unacceptable to the Owner, the Contractor shall perform the additional work or demonstrations required per the General Conditions.

END OF SECTION 017901

SECTION 017902 – INSTRUCTION OF OWNER'S PERSONNEL

PART 1 - GENERAL

1.1 DESCRIPTION

- A. General requirements for the conduct of training of permanent plant operating personnel on the care, maintenance and proper operation of the equipment. Specific requirements for training materials and for training are included in the individual Sections of the Contract Documents.

1.2 SUMMARY

- A. Work Included: Except as otherwise specifically provided in individual Sections of the Project Manual, work under this Section includes the preparation of the detailed lesson plans and the conduct of detailed training for permanent plant operating personnel. Training shall be conducted on all components of equipment, as specified in individual Sections of the Project Manual.
- B. Training sessions and hours for all equipment specified as requiring training shall be per the manufacturer's recommendations. However, in no case shall the number of sessions be less than two (2) to accommodate multiple shifts. Sessions shall cover maintenance, operations and electrical.

1.3 RELATED SECTIONS

- A. Section 013323 – Shop Drawings, Product Data and Submittals
- B. Section 017901 – Operational Demonstration

1.4 DEFINITIONS

- A. Lesson Plan: A Lesson Plan is a submittal containing a statement of the instructional objectives of the training, a training outline, credentials of the instructor, audio/visual requirements, a listing of training materials to be used, and the desired schedule times and dates.
- B. Training Aid: A mock-up, model, sample, or other device used during a training class to help demonstrate the maintenance, operation, or control of equipment.

1.5 SUBMITTALS

- A. Submittal of Instructor's credentials, Lesson Plans, instructional materials, training aids, and other training information shall be coordinated with the Training Schedule.
- B. Enough copies of instructional materials used for training for everyone present shall be provided at the time of the first training session.

- C. Provide two copies of all audio/visual aids utilized during training including films, slides, mock-ups, videotapes, DVDs or other training aids. All multimedia video shall be submitted in either Audio Video Interleave (AVI) format or Moving Pictures Expert Group (MPEG) format.
- D. Submit the following:
1. Proposed training Schedule for the entire Contract showing tentative dates for each training session: include number, type and duration of each session. This schedule shall be submitted 120 days prior to the commencement of any individual training being performed.
 2. The detailed credentials of the representative of the equipment manufacturer who is to be the course Instructor for each category and type of training. Include Instructor's name, education, knowledge of equipment, experience as a trainer and employment history with the manufacturer. Include specific details of Instructor's experience pertaining to the operation and maintenance of, the training for, the equipment or system specified. These credentials shall be submitted 60 days prior to the commencement of any training.
 3. The Lesson Plan shall be submitted sixty (60) days prior to the commencement of any training and shall cover all components of equipment, regardless of source of supply or manufacturer, and shall include:
 - a. A title page containing: Title of the Lesson Plan, product name and model of equipment; name of manufacturer, manufacturer address and phone number; name and phone number of manufacturer's contact; job location (Name of Facility); contract no.; specification number; Contractor name, address and phone number; subcontractor name, address, phone (if applicable); submittal number assigned by Contractor; and submittal date.
 - b. A table of contents listing the headings: instructional objectives; training outline; credentials of Instructor(s); audio/visual requirements; training materials to be used.
 - c. A detailed instructional objective statement on the goal(s) intended to have been achieved by the end of the training session.
 - d. The credentials of Instructors are to include name; education; knowledge of equipment; experience of trainer; and employment history with manufacturer.
 - e. The audio/visual requirements listing specific equipment that is to be provided by the Contractor for training purposes.
 - f. A list of all training materials to be used. An initial Operations and Maintenance (O&M) Instruction Manual, which has received an acceptable disposition, for the equipment shall be required to be utilized by the Instructor in the training and therefore shall be included on this list.
 - g. A request of schedule dates and times for each training session.
 - h. A training outline indicating the category of training (maintenance and operation, electrical and instrumentation or system); description of the session; length, and type (classroom or field). The training shall include as a minimum:
 - 1) Electrical and Instrumentation Training: System Equipment) Overview:
 - a) Describe system (equipment) fundamental operating principals and dynamics.
 - b) Identify system's (equipment's) mechanical, electrical and electronic components and features. Review system (equipment) wiring

- diagrams and process and instrumentation diagrams.
- c) Identify support systems (equipment) associated with the operation (e.g., air intake filters, valve actuators, motors).
 - d) Identify and describe safety precautions and potential hazards related to maintenance.
 - e) Identify and describe in detail safety and control interlocks.
 - f) Identify and describe alarm conditions and response to alarms.
 - g) Cover the supply of power to process equipment and related appurtenances, lighting, etc.
 - h) Cover low voltage controls, monitoring devices, etc.
- 2) Electrical and Instrumentation Training Equipment Preventive Maintenance (PM):
- a) Describe PM inspection procedures required to perform an inspection of the equipment in operation, spot potential trouble symptoms and anticipate breakdowns and forecast maintenance requirements (predictive maintenance).
 - b) Define the recommended PM intervals for each component.
 - c) Provide lubricant and replacement part recommendations and limitations.
 - d) Describe appropriate cleaning practices and recommend intervals.
 - e) Identify and describe the use of special tools required for maintenance of the equipment.
 - f) Describe component removal and installation, and disassembly and assembly procedures.
 - g) Perform at least 2 "field" demonstrations of preventive maintenance procedures.
 - h) Describe recommended measuring instruments and procedures, and provide instruction on interpreting alignment measurements, as appropriate.
 - i) Define recommended torque settings, mounting, calibration and alignment procedures and settings, as appropriate.
 - j) Describe recommended procedures to check or test equipment following a corrective repair.
- 3) Electrical and Instrumentation Training Equipment Troubleshooting:
- a) Define recommended systematic troubleshooting procedures.
 - b) Provide component specific troubleshooting checklists.
 - c) Describe applicable equipment testing and diagnostic procedures to facilitate troubleshooting.
- 4) Maintenance and Operation Training: System (Equipment) Overview:
- a) Describe system (equipment) operating (process) function and performance objectives.
 - b) Describe system (equipment) fundamental operating principals and dynamics.
 - c) Identify system's (equipment's) mechanical, electrical and electronic components and features.
 - d) Identify support systems (equipment) associated with the operation (e.g., air intake filters, valve actuators, motors).
 - e) Identify and describe safety precautions and potential hazards related to operation.

- f) For systems (equipment) comprised of several components: Identify and describe in detail each component's function. Where applicable, group related components into subsystems. Describe subsystem functions and their interaction with other subsystems.
 - g) Identify and describe in detail safety and control interlocks.
 - 5) Operation and Maintenance Training, Operation of Equipment:
 - a) Describe operating principles and practices.
 - b) Describe routine operating, start-up and shutdown procedures.
 - c) Describe abnormal or emergency start- up, operating, and shutdown procedures that may apply.
 - d) Describe alarm conditions and responses to alarms.
 - e) Describe routine monitoring and record keeping procedures.
 - f) Describe recommended housekeeping procedures.
 - 6) Operation and Maintenance Training, Troubleshooting:
 - a) Describe how to determine if either corrective maintenance or an operating parameter adjustment is required.
- 4. Once the Lesson Plan submittal has received an acceptable disposition but at least 3 weeks prior to the actual commencement of the training, Contractor shall submit the detailed training material as a Power Point presentation in an electronic format (either DVD, CDR, or flash drive/micro storage) with appropriate labeling. In addition to the electronic format the Power Point material shall be provided in hardcopy for Owner review and approval. The number of copies shall be as defined in Section 01061, Shop Drawings and Submittals. The text and lettering on the presentation slides shall not be smaller than 12 font size and shall be black in color. Slides shall have an appropriate light colored background, resulting in a high contrast between the text and background.
- 5. Sample Evaluation Form: Submit with Lesson Plan a sample Evaluation Form. Form shall include area for comments and evaluation of Instructor, classroom training and field instruction. Form shall identify Contract name and number, Specification Section, Job location, date and time of training, title of training session, name of manufacturer, model number of equipment, Instructor name, and Contractor and Subcontractor's name.

PART 2 – PRODUCTS

2.1 QUALIFICATIONS OF INSTRUCTOR

- A. The course Instructor shall be knowledgeable and experienced in the details of operation and maintenance of the equipment.
- B. The Instructor must be knowledgeable of the equipment's application specific to this work.
- C. The Owner will reject Instructors who are deemed not in compliance with the above stated minimum qualifications. The Contractor will submit for approval alternate Instructors for consideration. No additional cost will be allowed for replacement of Instructors who are unacceptable to the Owner.

PART 3 – EXECUTION

3.1 EXAMINATION AND VERIFICATION OF CONDITION

- A. The training site for the classroom instruction will be provided by the Owner. The Owner will provide this location.
- B. The Contractor shall coordinate and verify to ensure that, prior to the scheduled training time(s):
 - 1. The equipment is ready for Operational Demonstration in accordance with Section 017901, Operational Demonstration.
 - 2. That all associated construction required to operate the equipment in all normal and anticipated operating modes is complete.
 - 3. That the equipment area is well lit and unobstructed, so that all training class attendees may access, hear, and view the training.
 - 4. That the equipment area is free of construction activities that could present a hazard to training class participants.
 - 5. That adequate training materials, as required by paragraph 1.5 of this Section, are on hand for use during the training session.
 - 6. Any representatives of interfacing Contractors or equipment suppliers needed to perform supporting operations allowing demonstration of equipment operation have been notified and will be available.

3.2 PREPARATION

- A. Training classes shall be approved by the state-regulating agency for continuing education. This is in the event of the facility choosing to apply for CH/CEU credits for their training program.
- B. Videotaping of all training will be conducted by the Contractor. Before the start of training the Contractor, and the Contractor will review the training site(s) to establish acceptable sight lines, lighting and locations for the participants.
- C. Training classes shall be scheduled through the Owner. Training shall begin within 45 days to the beginning of the Operational Demonstration period. Certain training sessions will occur only during the Operational Demonstration period as specifically noted in the Contract Documents.
- D. Training classes shall be conducted and separated for the following personnel:
 - 1. Maintenance and Operation
 - 2. Electrical and Instrumentation
 - 3. Systems Training
- E. Audio-visual equipment available at the Owner's training sites include:
 - 1. Blackboards and/ or Whiteboards
- F. Verify training materials are compatible with all equipment. The Contractor is responsible for providing other audio/visual equipment and training aids as needed.

- G. Classroom and field instruction where specified shall be provided for each group. Field instruction will include attention to applied familiarization with the actual equipment. Training hours as required in the Contract Documents do not include travel, set-up or cleanup time by the Instructor.
- H. Training may be either "field" or "classroom" as specified. If not specifically noted, provide field training. For field training, the Instructor will demonstrate all operations of the equipment and may be expected to show assembly and disassembly procedures, maintenance procedures, replacement procedures, and the like. Field training will generally occur at the installed location of the equipment or material unless mock-ups are approved in the Lesson Plan and provided by the Contractor. Such mock-ups will become property of the Owner after the training sessions unless previously requested in the Lesson Plan.
- I. Systems Training: The Lesson will provide a detailed description of the system design, intended operation, and interactions of systems components. The Contractor's portion of Systems Training will provide additional detail descriptions of system's components and their interface with each other and other systems. Contractor's personnel for system training will be the same personnel who provided Operation and Maintenance training and Electrical and Instrumentation training.
- J. Training shall be conducted to accommodate the Owner's shift schedules. Contractor shall coordinate with Owner prior to scheduling the training sessions. Contractor shall anticipate multiple shifts.

3.3 CONDUCT OF TRAINING

- A. All topics of the approved Lesson Plan shall be discussed, in the classroom or the field, in complete and sufficient detail to allow plant operating personnel to knowledgeably operate and maintain the equipment in accordance with manufacturer's recommended procedures and safety considerations during all anticipated operational and maintenance situations.
- B. Safety concerns and features intended to enhance safety should be specifically addressed.
- C. Tasks required to maintain the warranty should be specifically addressed.
- D. Frequent reference shall be made to the Operation and Maintenance instructions.
- E. Address all questions and comments proposed by the training session participants as they are raised to the maximum extent practicable. If questions or comments cannot be addressed during the training session, additional materials and/or training may be required as determined by the Contractor.
- F. If any training session exceeds three (3) hours in duration, provide a 1/2- hour break.
- G. Ensure that all parts of the training session are legible or audible on the final tape. The Instructor must repeat all questions to insure that they are audible. Final acceptance of the training is contingent on the acceptability of the videotape.

- H. The Contractor will be back charged for cancelled training classes if the Owner is not notified at least 72 hours prior to scheduled training.
- I. Training Sessions shall be attended not only by the Owner's Operating Personnel but also by members of the Contractor or any other entities designated by the Owner.

3.4 EVALUATION

- A. Immediately following training, the Instructor shall pass out an evaluation form to the Owner's personnel. This form shall provide a means for the Owner's personnel to comment on the Instructor and the quality, completeness, and value of the session.
- B. Evaluation Forms shall be collected, along with the Attendance Sheet at the end of each training session and the original documents shall be submitted to the Owner for use in determining if additional training is required by the Contractor. If additional training is required due to the material as outlined in the Lesson Plan not being covered correctly or in its entirety or the inability of the Instructor to answer questions pertaining to the operation and maintenance of the equipment, or if the training aids or equipment fail to operate as intended, the Contractor shall provide such additional training at no additional cost to the Owner.

END OF SECTION 017902

SECTION 018000 - SYSTEM PERFORMANCES

PART 1 - GENERAL

1.1 GENERAL

- A. It is the intent of this Contract that the final installation shall be complete in all respects.
- B. The Contractor shall be responsible for all minor details, whether or not shown on the Drawings or specifically included in these Specifications.

1.2 BUILDINGS

- A. The building and components shall function properly and in accordance with the plans, specifications and industry standards.
- B. The following components are included, but not necessarily limited to, the following:
 - 1. Equipment
 - 2. Electrical

1.3 FACILITIES

- A. The facilities and equipment shall function properly and in accordance with plans, specifications and industry standards.
- B. The following equipment includes, but is not necessarily limited to, the following:
 - 1. Valves
 - 2. Pumping Equipment
 - 3. Rotating Equipment
 - 4. Mechanically Cleaned Bar Screens
 - 5. Grit Removal
 - 6. Aeration Equipment
 - 7. UV Disinfection
 - 8. Tertiary Filtration
 - 9. Dewatering Screw Press
 - 10. Instrumentation & Control, SCADA
 - 11. Electrical

1.4 CERTIFICATION

- A. The Contractor shall provide written certification from the manufacturers and/or installers that the various major components are in working order or have been installed in accordance with the manufacturer's instructions.

END OF SECTION 018000

SECTION 024100 - DEMOLITION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

1.2 DESCRIPTION OF WORK

- A. It is the intent of this section that the Contractor shall furnish all of the equipment, labor, and materials necessary to demolish various concrete structures and to remove, disconnect and/or transport some miscellaneous equipment from the site of the existing structure; together with all associated appurtenances as noted on the Contract Drawings, listed in the specifications herein, or as directed by the Engineer.

1.3 JOB CONDITION

- A. The Contractor shall exercise all necessary precaution to protect adjacent properties and roadways from falling debris, material, and sections during the demolition process. All necessary barricades to protect pedestrians and vehicular traffic will be installed.

1.4 SUBMITTALS

- A. The Contractor shall submit to the Engineer prior to the start of any proposed demolition, a written description of the method proposed to abandon, dismantle, or remove any of the structures or equipment located at the site. Under no circumstances will blasting or the use of explosives be allowed. All sewage within the tanks will be removed before demolition by maintaining pumping through the existing pump station or diverting it to the new pumping station facility.

1.5 SCHEDULE

- A. Demolition shall be scheduled and performed in strict conformance with these specifications and in a manner which will ensure no interruption of sewage pumping operations beyond that provided for and approved by the Owner. The date and the time of commencing the separate items of demolition work shall be submitted to the Engineer for review, and no demolition work shall commence until the Engineer's approval of date and time for the specific operation is in the hands of the Contractor.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 EXCAVATION, DEMOLITION & REMOVAL

- A. The Contractor shall be responsible for the excavation, demolition, removal, and transportation from the site of the facility to the satisfaction of the Engineer, including but not limited to the following:
 - 1. All piping, manholes, removed structural concrete from the alternations to the Oxidation Ditch Splitter Chamber, Final Clarifier No. 3 Splitter Box and other structures as shown on the Contract Drawings.

3.2 OWNERSHIP & DISPOSAL OF MATERIALS

- A. All materials shall be promptly removed from the construction site as demolition progresses. Material not sold for scrap value shall be transported to an approved land fill site for proper disposal.

END OF SECTION 024100

SECTION 024116 – STRUCTURE DEMOLITION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification sections, apply to work of this section.

1.2 DESCRIPTION OF WORK

- A. This section includes all demolition of existing structures and removal of pavement, piping, and equipment necessary to clear space for new construction and/or to rehabilitate existing construction.

1.3 REQUIREMENTS OF REGULATORY AGENCIES

- A. State and local code requirements shall control the disposal of debris resulting from the removal operation.

1.4 PROTECTION

- A. Structures shall be removed in such a manner as not to damage portions of the existing structure which are to remain in place.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 PAVEMENTS, SIDEWALKS, CURBING, SIMILAR STRUCTURES

- A. Removal of existing pavements, sidewalks, curbing, and similar structures shall end at an existing joint or a sawed joint. Sawed joints shall be straight, neat and free from chipped or damaged edges.
- B. For removal of reinforced or non-reinforced concrete, the minimum depth of saw cut shall be 3 in.
- C. For removal of reinforced concrete, the depth of saw cut shall be sufficient to cut the steel.
- D. If the concrete is coated with a bituminous surface or other material, the depth shall be sufficient to cut into the concrete, not including the coating depth, as specified above.

3.2 EXCAVATION OF RIGID PAVEMENT

- A. The Contractor shall excavate rigid pavement, consisting of concrete or concrete base with a wearing surface of brick or bituminous concrete, wherever such excavation is required for the purpose of this Contract.
- B. Pavement shall be excavated to neat lines and, only to widths required for trenches, for pipe laying and for construction of structures. Adequate provision shall be made to prevent settlement and breakage of pavement beyond the approved limits of excavation.
- C. All pavement broken or damaged beyond the limits above stated, or the approved extension thereof, shall be replaced by the Contractor at his expense.

3.3 MANHOLES, CATCH BASINS, INLETS AND SIMILAR STRUCTURES

- A. Existing drainage structure designated by the Engineer to be removed shall be completely removed.
- B. Catch basins, inlets, and similar structures designated to be abandoned shall be removed to an elevation of at least 3 ft. below the finished subgrade or ground surface. The remaining void shall be filled with selected backfill material compacted to 100% optimum density per ASTM D 698.
- C. Manholes designated by the Engineer to be abandoned shall be adjusted to 1' below proposed ground grade and the casting welded closed or an 8" reinforced concrete slab placed over the manhole.
- D. Live sewers connected to structures removed or abandoned shall be rebuilt through the area with new pipe. Sewer flow shall be maintained between removal and replacement operations. Abandoned sewers shall be sealed and made watertight with approved precast stoppers or masonry bulkheads.
- E. All castings salvaged from abandoned or removed drainage structures shall remain the property of the Owner and shall be cleaned and transported by the Contractor to a site designated by the Engineer or incorporated in the work where called for on the Drawings, scheduled, or so directed.

3.4 GUARDRAIL AND FENCE

- A. Where so required by the Drawings, existing guardrail and fence shall be carefully dismantled and stored for reuse or for salvage by the Owner.
- B. Wood posts and other materials not considered salvageable by the Engineer shall be disposed of by the Contractor.

- C. The Contractor will be required to replace, at no cost to the Owner, material lost or damaged by negligence or by the use of improper methods.

3.5 SUPERSTRUCTURES, TANKS, CHAMBERS AND SIMILAR STRUCTURES

- A. Care shall be used in demolishing structural elements which are continuous with structural elements remaining in service. Concrete and masonry shall be cut with a masonry or concrete saw before removing unwanted portions.
- B. Methods and equipment used in demolition work shall be chosen so the structural integrity and water-tightness of both newly constructed and existing plant structures remain unimpaired by the performance of the demolition work.
- C. Existing structures and equipment which are damaged in appearance and/or function by performance of demolition work shall be replaced or repaired to approved first-class condition by the Contractor at not increase in Contract Price.
- D. Extreme care shall be used when removing existing concrete from around reinforcing steel which must be used for securing new concrete. If this reinforcing steel is damaged, the Contractor shall remove additional existing concrete until sufficient existing reinforcing steel is exposed to provide adequate embedment length in the new concrete, as approved by the Engineer.
- E. Abandoned pipes shall be sealed and made watertight with approved precast stoppers or masonry bulkheads.

3.6 EQUIPMENT REMOVAL

- A. All equipment, valves, piping, fittings, and miscellaneous steel structures that are removed shall remain the property of the Owner and shall be stored at site selected by the Owner. The Owner reserves the right to require the Contractor to dispose of certain unwanted portions of removed equipment and materials. The Owner shall have the right to reject any or all materials removed during construction, and the Contractor shall haul away and dispose of these materials in a suitable manner at no additional cost to the Owner.

3.7 DISPOSAL OF DEBRIS

- A. All debris resulting from demolition operations; i.e., broken concrete, masonry, pipe, miscellaneous metal, trees and brush, equipment, etc., shall be disposed of off-site.
- B. The Contractor shall police the hauling of debris to insure that all spillage from haul trucks is promptly and completely removed.

3.8 BACKFILLING

- A. All trenches, holes, and pits resulting from the removal and abandonment of any structure or obstruction shall be backfilled and compacted in accordance with the requirements of Section 312333.

END OF SECTION 024116

SECTION 024119.16 - MINOR ALTERATION WORK

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification sections, apply to work of this section.

1.2 DESCRIPTION OF WORK

- A. Alteration work is indicated on the drawings.

1.3 QUALITY ASSURANCE

- A. Test materials to be used in making repairs for compatibility with existing materials. Do not proceed with repairs until Engineer approves tests. Do not use incompatible materials.

1.4 JOB CONDITIONS

- A. Disconnecting Services:

- 1. Notify Owner and authorities owning or controlling affected services before starting operations.

- B. Movement, settlement, and other damage to existing building due to alterations work:

- 1. Be solely responsible for: correct damage from inadequate, improper, or careless construction procedures, or inadequate shoring, bracing, support or protection.

- C. Differing conditions:

- 1. Should materials, systems or conditions be encountered that differ from those indicated, immediately notify Engineer and do not proceed without instructions.

PART 2 - PRODUCTS

2.1 SALVAGED MATERIALS AND ITEMS

- A. Materials and items to be reused:

- 1. Reinstall materials and items so shown, or which are removed to make it possible to do the work, in the same location from which removed unless indicated otherwise.

B. Preparing for reuse:

1. Clean salvaged materials and items that will be reinstalled. Reused materials shall be in good condition without objectionable chips, cracks, splits, checks, dents, scratches, or other defects. Operating items shall operate properly.

2.2 NEW MATERIALS

A. General:

1. Provide new materials to match existing adjacent materials for closing of openings, repairs, and reconstruction where suitable salvaged materials do not exist or are insufficient in quantity to complete the work, or where reuse is not permitted. New materials to match existing shall be same types, sizes, qualities, and colors, as existing materials.

- B. Materials for repairing existing surfaces, but not otherwise specified, shall conform to the highest standards of trade involved, and be in accordance with approved industry standards.

PART 3 - EXECUTION

3.1 ALTERATIONS, PATCHING AND REPAIRS

A. General:

1. Patches and repairs shall not be discernible from normal viewing distance.

B. Restoring existing finishes:

1. Restore finishes damaged or defaced because of cutting, patching, demolition, alteration, or repair work, to condition equal to that before work began. Where work exposes damaged or unfinished surfaces, repair and finish or refinish, or remove the damaged or unfinished materials, and provide new or salvaged, acceptable, matching materials, to make continuous areas and surface uniform.

C. Workmanship:

1. Perform new work and restore and refinish existing work to comply with applicable requirements of the specifications. Workmanship for repairing existing materials not otherwise specified shall conform to similar workmanship existing in or adjacent to space where alterations are to be made. Reinstall salvaged items where no similar items exist, in accordance with the highest standards of trade involved and in accordance with approved shop drawings.

END OF SECTION 024119.16

SECTION 030000 - CONCRETE WORK

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.
 - 1. Section 013319 – Field Testing Requirements

1.2 SUMMARY

- A. This Section specifies cast-in place concrete, including form work, reinforcing, mix design, placement procedures and finishes.
 - 1. Extent of concrete work is shown on drawings.
 - 2. Concrete paving and walks are specified in Division 32.
 - 3. Precast concrete is specified in other Division 03.
 - 4. Mechanical finishes and concrete floor toppings are specified in other Division 03.

1.3 SUBMITTALS

- A. Product Data: Submit data for proprietary materials and items, including reinforcement and forming accessories, admixtures, patching compounds, waterstops, joint systems, curing compounds, dry-shake finish materials, and others as requested by Engineer.
- B. Shop Drawings; Reinforcement: Submit original shop drawings prepared for fabrication, bending, and placement of concrete reinforcement. Comply with ACI Detailing Manual showing bar schedules, stirrup spacing, diagrams of bent bars, arrangement of concrete reinforcement. Include special reinforcement required for openings through concrete structures.
- C. Shop Drawings; Form work: Submit shop drawings prepared by a registered Professional Engineer for fabrication and erection of forms for specific finished concrete surfaces. Show form construction including jointing, special form joints or reveals, location and pattern of form tie placement, and other items which affect exposed concrete visually.
 - 1. Engineer's review is for general architectural applications and features only. Design of form work for structural stability and efficiency is Contractor's responsibility.
- D. Samples: Submit samples of materials as requested by Engineer, including names, sources, and descriptions.
- E. Laboratory Test Reports: Submit laboratory test reports for concrete materials and mix design tests.

1. The proposed mix design submittal(s) shall follow the procedures of Chapter 5, Sections 5.2 to 5.3 of ACI-318.
 2. Reference should be made to ACI-211.5R "Guide for Submittal of Concrete Proportions" for the required submittal information. Sample forms for presenting the necessary information can be found in the addendum at the end of this section. Example Form B should follow a completed Example A in the submittal when laboratory trial batches are used to document a water-cementitious materials ratio curve.
 3. Additional data summarizing the past performance records should be an integral part of the submittal if the submittal is based on past performance with the proposed materials and proportions.
- F. Materials Certificates: Provide materials certificates in lieu of materials laboratory test reports when permitted by Engineer. Materials certificates shall be signed by manufacturer and Contractor, certifying that each material item complies with, or exceeds, specified requirements. Provide certification from admixture manufacturers that chloride content complies with specification requirements.

1.4 QUALITY ASSURANCE

- A. Codes and Standards: Comply with provisions of following codes, specifications, and standards, latest revisions, except where more stringent requirements are shown or specified:
1. ACI 301 "Specifications for Structural Concrete for Buildings."
 2. ACI 318 "Building Code Requirements for Reinforced Concrete."
 3. Concrete Reinforcing Steel Institute (CRSI), "Manual of Standard Practice."
 4. ACI 347 "Guide to Form work for Concrete."
 5. ACI 117, "Specifications for Tolerances for Concrete Construction and Materials."
 6. ACI 350-20, "Code Requirements for Environmental Engineering Concrete Structures."
- B. Materials and installed work may require testing and retesting at any time during progress of work. Tests, including retesting of rejected materials for installed work, shall be done at Contractor's expense.
- C. Engage a testing agency acceptable to Engineer to perform initial material evaluation and certification tests for mix designs and to design concrete mixes.
- D. Mockup: Cast mockup of size indicated or as required to demonstrate typical joints, form tie spacing, and proposed surface finish, texture, and color. Maintain sample panel exposed to view for duration of project, after Engineer's acceptance of visual qualities.
1. Demolish mockup and remove from site when directed by Engineer.
- E. Pre-installation Conference: Conduct conference at project site to comply with requirements of Division 1 Section "Project Meetings" and the following:

1. At least 35 days prior to submitting design mixes, conduct a meeting to review detailed requirements for preparing concrete design mixes and to determine procedures for satisfactory concrete operations. Review requirements for submittals, status of coordinating work, and availability of materials. Establish preliminary work progress schedule and procedures for materials, inspection, testing and certifications. Require representatives of each entity directly concerned with cast-in-place concrete to attend conference, including, but not limited to, the following:
 - a. Contractor's Superintendent
 - b. Agency responsible for concrete design mixes.
 - c. Agency responsible for field quality control.
 - d. Ready-mix concrete producer.
 - e. Concrete Subcontractor
 - f. Primary admixture manufactures.

1.5 PROJECT CONDITIONS

- A. Protection of Footings Against Freezing: Cover completed work at footing level with sufficient temporary or permanent cover as required to protect footings and adjacent subgrade against possibility of freezing; maintain cover for time period as necessary.
- B. Protect adjacent finish materials against spatter during concrete placement.

PART 2 - PRODUCTS

2.1 FORM MATERIALS

- A. Forms for Exposed Finish Concrete: Plywood, metal, metal-framed plywood faced, or other acceptable panel-type materials, to provide continuous, straight, smooth, exposed surfaces. Furnish in largest practicable sizes to minimize number of joints and to conform to joint system shown on drawings.
 1. Use plywood complying with U.S. Product Standard PS-1 "B-B (Concrete Form) Plywood," Class I, Exterior Grade or better, mill-oiled and edge-sealed, with each piece bearing legible inspection trademark.
- B. Forms for Unexposed Finish Concrete: Plywood, lumber, metal, or other acceptable material. Provide lumber dressed on at least two (2) edges and one side for tight fit.
- C. Forms for Textured Finish Concrete: Units of face design, size, arrangement, and configuration to match Engineer's control sample. Provide solid backing and form supports to ensure stability of textured form liners.
- D. Forms for Cylindrical Columns and Supports: Metal, fiberglass reinforced plastic, or paper or fiber tubes. Construct paper or fiber tubes of laminated plies using water-resistant adhesive

with wax-impregnated exterior for weather and moisture protection. Provide units with sufficient wall thickness to resist loads imposed by wet concrete without deformation.

- E. Form Coatings: Provide commercial formulation form-coating compounds that will not bond with, stain, nor adversely affect concrete surfaces, and will not impair subsequent treatments of concrete surfaces.
- F. Form Ties: Factory-fabricated, adjustable-length, snapoff metal or glass fiber-reinforced plastic form ties, designed to prevent form deflection and to prevent spalling concrete upon removal. Provide units which will leave no metal closer than 1-1/2" to the exposed surface.
 - 1. Provide ties which, when removed, will leave holes not larger than 1" diameter in concrete surface.
 - 2. All form ties shall have a factor of safety of two (2) to determine the recommended safe working load.

2.2 REINFORCING MATERIALS

- A. Reinforcing Bars: ASTM A 615, Grade 60, deformed.
- B. Galvanized Reinforcing Bars: ASTM A 767, Class II (2.0 oz. zinc psf) hot-dip galvanized, after fabrication and bending.
- C. Epoxy-Coated Reinforcing Bars: ASTM A 775.
 - 1. Repair of damaged epoxy-coating - When required, damaged epoxy-coating shall be repaired with patching material conforming to ASTM A 775. Repair shall be done in accordance with the patching material manufacturer's recommendations.
- D. Steel Wire: ASTM A 82, plain, cold-drawn steel.
- E. Welded Wire Fabric: ASTM A 185, welded steel wire fabric. (Flat sheets only)
- F. Welded Deformed Steel Wire Fabric: ASTM A 497.
- G. Epoxy - Coated Welded Wire Fabric: ASTM A884, Class A.
- H. Supports for Reinforcement: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded wire fabric in place. Use wire bar type supports complying with CRSI specifications.
 - 1. For slabs-on-grade, use supports with sand plates or horizontal runners where base material will not support chair legs.
 - 2. For exposed-to-view concrete surfaces, where legs of supports are in contact with forms, provide supports with legs which are plastic protected (CRSI, Class 1) or stainless steel protected (CRSI, Class 2).

2.1 CONCRETE MATERIALS

- A. Portland Cement: ASTM C 150, Type I, II or I/II and ASTM C595M, Type IP, unless otherwise specified. (See Table I, Concrete Requirements).
 - 1. Use one brand of cement throughout project, unless otherwise acceptable to Engineer.
- B. Fly Ash: ASTM C 618, Class F.
 - 1. When used, proportion of fly ash shall comply with ACI 350-20 Tables 4.1.3(a) through 4.1.3(d).
- C. Ground Granulated Blast-Furnace Slag: ASTM C989, Grade 100 or 120.
 - 1. When used, proportion of ground granulated blast-furnace slag shall comply with ACI 350-20 Tables 4.1.3(a) through 4.1.3(d).
- D. Normal Weight Aggregates: ASTM C 33, and as herein specified. Provide aggregates from a single source for exposed concrete, with nominal maximum aggregate size of 1 inch.
 - 1. For exterior exposed surfaces, do not use fine or coarse aggregates containing spalling-causing deleterious substances.
 - 2. Local aggregates not complying with ASTM C 33 but which have shown by special test or actual service to produce concrete of adequate strength and durability may be used when acceptable to Engineer.
 - 3. Combined Aggregate Gradation: Well graded from coarsest to finest with not more than 18 percent and not less than 8 percent retained on an individual sieve, except that less than 8 percent may be retained on coarsest sieve and on No. 50 (0.3-mm) sieve, and less than 8 percent may be retained on sieves finer than No. 50 (0.3 mm).
 - 4. Maximum aggregate size for Class E concrete and for Class B concrete in applications thinner than 2 inches is No. 8 (9.5 mm – 2.36 mm).
- E. Lightweight Aggregates: ASTM C 330.
 - Maximum nominal aggregate size of 1 inch.
- F. Water: Drinkable and complying with ASTM C94.
- G. Air-Entraining Admixture: ASTM C 260, certified by manufacturer to be compatible with other required admixtures.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. "Air-Mix"; Euclid Chemical Co.
 - b. "Sika Aer"; Sika Corp.
 - c. "MB-VR or MB-AE"; Master Builders.

- H. Water-Reducing Admixture: ASTM C 494, Type A, and containing not more than 0.1 percent chloride ions.
1. Products: Subject to compliance with requirements, provide one of the following:
 - a. "WRDA"; W.R. Grace.
 - b. "Eucon WR-75"; Euclid Chemical Co.
 - c. "Pozzolith Normal"; Master Builders.
- I. High-Range Water-Reducing Admixture (Super Plasticizer): ASTM C 494, Type F and containing not more than 0.1 percent chloride ions.
1. Products: Subject to compliance with requirements, provide one of the following:
 - a. "Sikament 300"; Sika Chemical Corp.
 - b. "Eucon 37"; Euclid Chemical Co.
 - c. "Rheobuild or Polyheed"; Master Builders.
- J. Water-Reducing, Non-Chloride Accelerator Admixture: ASTM C 494, Type E, and containing not more than 0.1 percent chloride ions.
1. Products: Subject to compliance with requirements, provide one of the following:
 - a. "Accelguard 80"; Euclid Chemical Co.
 - b. "Pozzutec 20"; Master Builders.
 - c. "Daraset"; W.R. Grace & Co.
- K. Water-Reducing, Retarding Admixture: ASTM C 494, Type D, and containing not more than 0.1 percent chloride ions.
1. Products: Subject to compliance with requirements, provide one of the following:
 - a. "Pozzolith"; Master Builders.
 - b. "Eucon Retarder 75"; Euclid Chemical Co.
 - c. "Plastiment"; Sika Chemical Co.
- L. Corrosion-Inhibiting Admixture: Commercially formulated, anodic inhibitor or mixed cathodic and anodic inhibitor; capable of forming a protective barrier and minimizing chloride reactions with steel reinforcement in concrete.
1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:
 2. Products: Subject to compliance with requirements, provide one of the following:
 - a. Catexol 1000CL; Axim Concrete Technologies.
 - b. MCI 2000 or MCI 2005; Cortec Corporation.
 - c. DCI or DCI-S; W.R. Grace & Co., Construction Products Div.

- d. Rheocrete 222+; Master Builders, Inc.
 - e. FerroGard-901; Sika Corporation.
- M. Prohibited Admixtures: Calcium chloride thycyanates or admixtures containing more than 0.05 percent chloride ions are not permitted.
- N. Fiber Reinforcement:
- 1. Synthetic fiber reinforcing shall be added to the concrete for the areas so indicated in the drawings. Only fibers designed and manufactured specifically for use in concrete shall be acceptable as secondary reinforcement, complying with ASTM C1116, not less than 3/4 inch long.
 - 2. The fibers may be added at the batch plant. The incorporation of said fibers shall be documented on the delivery ticket from the ready-mix producer. Fibers shall be added to the concrete in strict accordance with manufacturer's printed instructions. The minimum dosage rate shall be 1.5 lbs/cubic yard.
 - 3. Nylon fibers containing 100% virgin nylon monofilaments shall be utilized to impart a "non-hairy" surface to the finished concrete.
 - 4. Products: Subject to compliance with requirements, provide the following fibrous reinforcement or approved equal:
 - a. Nycon Fiber; Nycon, Inc.
 - b. Nylo-Mono; Forta Corp.
 - c. Fibrasol N; Axim Concrete Technologies

2.2 RELATED MATERIALS

- A. Reglets: Where resilient or elastomeric sheet flashing or bituminous membranes are terminated in reglets, provide reglets of not less than 26 gage galvanized sheet steel. Fill reglet or cover face opening to prevent intrusion of concrete or debris.
- B. Waterstops: Provide waterstops at construction joints and other joints as indicated and specified in Section 030000.02.
- C. Granular Base: Evenly graded mixture of fine and coarse aggregates to provide, when compacted, a smooth and even surface below slabs on grade.
- D. Vapor Retarder: Provide vapor retarder cover, ASTM E1745 Class C, over prepared base material where indicated below slabs on grade. Use only materials which are resistant to deterioration when tested in accordance with ASTM E 154, as follows:
 - 1. Polyethylene sheet not less than 10 mils thick.
 - 2. Water resistant barrier paper consisting of heavy Kraft papers laminated together with glass fiber reinforcement and over-coated with black polyethylene on each side.

- a. Product: Subject to compliance with requirements, provide Moistop Ultra 10 by Fortifiber Corporation, Stego Wrap 10-mil by Stego Industries or equal.
- E. Non-Shrink Grout: CRD-C 621 and ASTM C-1107, factory pre-mixed grout.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Non-metallic
 - 1) "Set Grout"; Master Builders.
 - 2) "Euco-NS"; Euclid Chemical Co.
 - 3) "Five Star Grout"; U.S. Grout Corp.
- F. Non-slip Aggregate Finish: Provide fused aluminum oxide grits, or crushed emery, as abrasive aggregate for non-slip finish with emery aggregate containing not less than 50 percent aluminum oxide and not less than 25 percent ferric oxide. Use material that is factory-graded, packaged, rust-proof, and non-glazing, and is unaffected by freezing, moisture, and cleaning materials.
- G. Colored Wear-Resistant Finish: Packaged, dry, combination of materials, consisting of Portland cement, graded quartz aggregate, coloring pigments, and plasticizing admixture. Use coloring pigments that are finely ground, non-fading mineral oxides, interground with cement. Color as selected by Engineer, unless otherwise indicated.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. "Colorcron"; Master Builders.
 - b. "Surflex"; Euclid Chemical Co.
 - c. "Lithochrome"; L.M. Scofield Co.
- H. Absorptive Cover: Burlap cloth made from jute or kenaf, weighing approximately 9 oz. per sq. yd., complying with AASHTO M 182, Class 2.
- I. Moisture-Retaining Cover: One of the following, complying with ASTM C 171.
 - 1. Waterproof paper.
 - 2. Polyethylene film.
 - 3. Polyethylene-coated burlap.
- J. Liquid Membrane-Forming Curing Compound: Liquid type membrane- forming curing compound complying with ASTM C 309, Type I, Class A. Moisture loss not more than 0.55 kg./sq. m. when applied at 200 sq ft./gal.
 - 1. Products: Subject to compliance with requirements, provide one of the following:

- a. "Masterkure"; Master Builders.
 - b. "Ecocure"; Euclid Chemical Co.
 - c. "Horn Clear Seal"; A.C. Horn, Inc.
- K. Underlayment Compound: Freeflowing, self-leveling, pumpable cementitious base compound for applications from 1 inch thick to feathered edges.
- 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. "Flo-Top"; Euclid Chemical Co.
 - b. "Underlayment 110," Master Builders, Inc.
 - c. "Thoro Underlayment Self-Leveling"; Thoro System Products.
- L. Bonding Compound: Polyvinyl acetate or acrylic base.
- 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Polyvinyl Acetate (Interior Only):
 - 1) "Euco Weld"; Euclid Chemical Co.
 - 2) "Weldcrete"; Larsen Products Corp.
 - 3) "Everweld"; L&M Construction Chemicals, Inc.
 - b. Acrylic or Styrene Butadiene:
 - 1) "Day-Chem AD Bond"; Dayton Superior Corp.
 - 2) "Everbond"; L & M Construction Chemicals.
 - 3) "SBR Latex"; Euclid Chemical Co.
- M. Epoxy Adhesive: ASTM C 881, two component material suitable for use on dry or damp surfaces. Provide material "Type," "Grade," and "Class" to suit project requirements.
- 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. "Epoxite Binder 2390"; A.C. Horn, Inc.
 - b. "Sikadur 32 Hi-Mod"; Sika Chemical Corp.
 - c. "Euco Epoxy 452 or 620"; Euclid Chemical Co.

2.3 PROPORTIONING AND DESIGN OF MIXES

- A. Prepare design mixes for each type and strength of concrete by either laboratory trial batch or field experience methods as specified in ACI 301 and ACI 211. If the trial batch method is used, use an independent testing facility acceptable to Engineer for preparing and reporting proposed mix designs. The testing facility shall not be the same as used for field quality control testing unless otherwise acceptable to Engineer.

1. When used, proportions of supplementary cementitious materials (fly ash or ground granulated blast-furnace slag) shall comply with Tables 4.1.3(a) through 4.1.3(d).
- B. Submit written reports to Engineer and Structural Engineer of each proposed mix for each class of concrete at least 15 days prior to start of work. Do not begin concrete production until mixes have been reviewed by Engineer.
- C. Design mixes to provide normal weight concrete with the following properties, as indicated in Table 1:

TABLE 1
CONCRETE REQUIREMENTS

Concrete Class	Cement Type	Min. 28-Day Compressive Strength PSI	*Max. Water-Cement Ratio	Min. Cement Content Sacks	Slump Min.	Inch Max.	Entrained Air % Air %
A	I	4000	0.45	6	-	-	6±1
B	I	2000	0.74	4-1/2	2	6	5±1-1/2
C	I	4000	0.50	6.38	1	4	6±2
D	II or IP	5000	0.40	6	-	-	6±1
E	II or IP	5000	0.40	6	2	6	6±1

*Maximum Water - Cementitious Materials Ratio

1. All reinforced concrete shall be Class D, except as otherwise specified or shown on the drawings.
2. Concrete used for mud mats, fill and channeling in manholes and chambers shall be Class B unless otherwise noted on the drawings.
3. Class C concrete conforming to ODOT 499 (Class C) shall be used for all concrete pavement, curbing, driveways, and sidewalks, unless noted otherwise on the drawings.
4. Class B concrete may be used for encasing pipelines, fill, and pipe bedding.
5. Class B concrete shall be used as concrete fill in concrete tanks for shaping or sloping bottoms.
 - a. The following steps shall be taken for installation of the Class B concrete:
 - 1) Scrub concrete slabs and/or walls with a stiff wire brush and streams of clean water as a minimum, to remove laitance.
 - 2) Apply a bonding agent in accordance with the manufacturer's surface preparation and application recommendations.

- 3) The Class B concrete shall then be placed and screeded to bring the surface to final grade.
6. Class D concrete shall be used for sewerage treatment plants and sewerage pump stations, as noted on the drawings.
7. Class E concrete shall be used for structural topping where noted in the Drawings.
8. All mix designs shall conform to the following categories, as indicated in Table 2:

TABLE 2

EXPOSURE CATEGORIES

<u>CATEGORY</u>	<u>CLASS</u>
Freezing and Thawing	EF3
Sulfate	ES1
Corrosion Protection	EC2
Protection From Chemical Attack	ECA2
Protection From Erosion	EE1

- D. Lightweight Concrete: Lightweight aggregate and concrete shall conform to ASTM C 330. Proportion mix to produce concrete with a minimum compressive strength of 3000 psi at 28 days and a calculated equilibrium unit weight of 110 pcf plus or minus 3 pcf as determined by ASTM C 567. Concrete slump at the point of placement shall be the minimum necessary for efficient mixing, placing, and finishing. Maximum slump shall be 6 inches for pumped concrete and 5 inches elsewhere. Air entrain concrete exposed to weather according to ACI 301 requirements.
- E. Adjustment to Concrete Mixes: Mix design adjustments may be requested by Contractor when characteristics of materials, job conditions, weather, test results, or other circumstances warrant; at no additional cost to Owner and as accepted by Engineer. Laboratory test data for revised mix design and strength results must be submitted to and accepted by Engineer before using in work.
- F. Admixtures:
 1. Use high range water-reducing admixture (super plasticizer) in Classes A and D concrete unless noted otherwise.
 2. Use non-chloride accelerating admixture in concrete slabs placed at ambient temperatures below 50 deg F (10 deg C).

3. Use air-entraining admixture in all concrete, unless otherwise indicated. Add air-entraining admixture at manufacturer's prescribed rate to result in concrete at point of placement having total air content within limits shown in Table I.
4. Use admixtures for water-reducing and set-control in strict compliance with manufacturer's directions.
5. Slump Limits: Proportion and design mixes to result in concrete slump at point of placement as shown in Table I:
 - a. Concrete containing HRWR admixture (super-plasticizer): Not more than 8" after addition of HRWR to site-verified 2"-3" slump concrete.

2.4 CONCRETE MIXING

- A. Job-Site Mixing: Mix materials for concrete in appropriate drum type batch machine mixer. For mixers of one cu. yd., or smaller capacity, continue mixing at least 1-1/2 minutes, but not more than 5 minutes after ingredients are in mixer, before any part of batch is released. For mixers of capacity larger than one cu. yd., increase minimum 1-1/2 minutes of mixing time by 15 seconds for each additional cu. yd., or fraction thereof.
 1. Provide batch ticket for each batch discharged and used in work, indicating project identification name and number, date, mix type, mix time, quantity, and amount of water introduced.
- B. Ready-Mix Concrete: Comply with requirements of ASTM C 94, and as herein specified.
 1. During hot weather, or under conditions contributing to rapid setting of concrete, a shorter mixing time than specified in ASTM C 94 may be required.
 - a. When air temperature is between 85 deg F (30 deg C) and 90 deg F (32 deg C), reduce mixing and delivery time from 1-1/2 hours to 75 minutes, and when air temperature is above 90 deg F (32 deg C), reduce mixing and delivery time to 60 minutes.

PART 3 - EXECUTION

3.1 GENERAL

- A. Coordinate the installation of joint materials and vapor retarders with placement of forms and reinforcing steel.

3.2 FORMS

- A. Design, erect, support, brace, and maintain form work to support vertical and lateral, static, and dynamic loads that might be applied until such loads can be supported by concrete structure. Construct form work so concrete members and structures are of correct size,

shape, alignment, elevation, and position. Maintain form work construction tolerances complying with ACI 347.

- B. Design form work to be readily removable without impact, shock, or damage to cast-in-place concrete surfaces and adjacent materials.
- C. Construct forms to sizes, shapes, lines, and dimensions shown, and to obtain accurate alignment, location, grades, level and plumb work in finished structures. Provide for openings, offsets, sinkages, keyways, recesses, moldings, rustications, reglets, chamfers, blocking, screeds, bulkheads, anchorages and inserts, and other features required in work. Use selected materials to obtain required finishes. Solidly butt joints and provide back-up at joints to prevent leakage of cement paste.
- D. Fabricate forms for easy removal without hammering or prying against concrete surfaces. Provide crush plates or wrecking plates where stripping may damage cast concrete surfaces. Provide top forms for inclined surfaces where slope is too steep to place concrete with bottom forms only. Kerf wood inserts for forming keyways, reglets, recesses, and the like, to prevent swelling and for easy removal.
- E. Provide temporary openings where interior area of form work is inaccessible for cleanout, for inspection before concrete placement, and for placement of concrete. Securely brace temporary openings and set tightly to forms to prevent loss of concrete mortar. Locate temporary openings on forms at inconspicuous locations.
- F. Chamfer exposed corners and edges as indicated, using wood, metal, PVC, or rubber chamfer strips fabricated to produce uniform smooth lines and tight edge joints.
- G. Provisions for Other Trades: Provide openings in concrete form work to accommodate work of other trades. Determine size and location of openings, recesses, and chases from trades providing such items. Accurately place and securely support items built into forms.
- H. Cleaning and Tightening: Thoroughly clean forms and adjacent surfaces to receive concrete. Remove chips, wood, sawdust, dirt, or other debris just before concrete is placed. Retightening forms and bracing after concrete placement if required to eliminate mortar leaks and maintain proper alignment.

3.3 VAPOR RETARDER INSTALLATION

- A. Following leveling and tamping of granular base for slabs on grade, place vapor retarder sheeting with longest dimension parallel with direction of pour.
- B. Lap joints 6" and seal with manufacturer's recommended mastic or pressure-sensitive tape.

3.4 PLACING REINFORCEMENT

- A. Comply with Concrete Reinforcing Steel Institute's recommended practice for "Placing Reinforcing Bars," for details and methods of reinforcement placement and supports, and as herein specified.
 - 1. Avoiding cutting or puncturing vapor retarder during reinforcement placement and concreting operations. Repair damages before placing concrete.
- B. Clean reinforcement of loose rust and mill scale, earth, ice, and other materials which reduce or destroy bond with concrete.
- C. Accurately position, support, and secure reinforcement against displacement by form work, construction, or concrete placement operations. Locate and support reinforcing by metal chairs, runners, bolsters, spacers, and hangers, as required.
- D. Place reinforcement to obtain at least minimum coverages for concrete protection. Arrange, space, and securely tie bars and bar supports to hold reinforcement in position during concrete placement operations. Set wire ties so ends are directed into concrete, not toward exposed concrete surfaces.
- E. Install welded wire fabric in longest lengths as practicable. Lap adjoining pieces at least one full mesh and lace splices with wire. Offset end laps in adjacent widths to prevent continuous laps in either direction.
- F. Epoxy - Coated Reinforcing Steel:
 - 1. Epoxy-coated reinforcing bars supported from form work shall rest on coated wire bar supports, or on bar supports made of dielectric material or other acceptable materials. Wire bar supports shall be coated with dielectric material for a minimum distance of 2 inches from the point of contact with the epoxy-coated reinforcing bars. Reinforcing bars used as support bars shall be epoxy-coated.
In walls having epoxy-coated reinforcing bars, spreader bars where specified by the Engineer, shall be epoxy-coated. Proprietary combination bar clips and spreaders used in walls with epoxy-coated reinforcing bars shall be made of corrosion-resistant material.
Epoxy-coated reinforcing bars - Equipment for handling epoxy-coated bars shall have protected contact areas. Bundles of coated bars shall be lifted at multiple pick-up points to minimize bar-to-bar abrasion from sags in the bundles. Coated bars or bundles of coated bars shall not be dropped or dragged. Coated bars shall be stored on protective cribbing. Fading of the color of the coating shall not be cause for rejection of epoxy-coated reinforcing bars. Coating damage due to handling, shipment and placing need not be repaired in cases where the damaged area is 0.1 square inches or smaller. Damaged areas larger than 0.1 square inches shall be repaired in accordance with the epoxy material manufacturer's recommendations. The maximum amount of damage including repaired and unrepaired areas shall not exceed 2 percent of the surface area in each linear foot of each bar.

3.5 JOINTS

- A. Construction Joints: Locate and install construction joints as indicated or, if not indicated, locate so as not to impair strength and appearance of the structure, as acceptable to Engineer.
 - 1. Provide keyways at least 1-1/2" deep in construction joints in walls, slabs, and between walls and footings; accepted bulkheads designed for this purpose may be used for slabs.
 - 2. Place construction joints perpendicular to main reinforcement. Continue reinforcement across construction joints, except as otherwise indicated.
- B. Waterstops: Provide waterstops in construction joints as indicated. Install waterstops to form continuous diaphragm in each joint. Make provisions to support and protect exposed waterstops during progress of work. Fabricate field joints in waterstops in accordance with manufacturer's printed instructions.
- C. Isolation Joints in Slabs-on-Ground: Construct isolation joints in slabs-on-ground at points of contact between slabs-on-ground and vertical surfaces, such as column pedestals, foundation walls, grade beams, and elsewhere as indicated.
 - 1. Joint filler and sealant materials are specified in Section 030000.02 of these specifications.
- D. Contraction Joints in Slabs-on-Ground: Construct contraction joints in slabs-on-ground to form panels of patterns as shown. Use inserts 1/4 of slab depth, unless otherwise indicated.
 - 1. Form contraction joints by inserting premolded plastic strips into fresh concrete until top surface of strip is flush with slab surface.
 - 2. Follow the directions of Insert Manufacturer for finishing the slab and joints.
- E. If joint pattern not shown, provide joints not exceeding 15' in either direction and located to conform to bay spacing wherever possible (at column centerlines, half bays, third-bays).
 - 1. Joint sealant material is specified in Section 030000.02 of these specifications.

3.6 INSTALLATION OF EMBEDDED ITEMS

- A. General: Set and build into work anchorage devices and other embedded items required for other work that is attached to, or supported by, cast-in-place concrete. Use setting drawings, diagrams, instructions, and directions provided by suppliers of items to be attached thereto. Electrical conduit shall not be embedded in concrete.
- B. Install reglets to receive top edge of foundation sheet waterproofing, and to receive thru-wall flashings in outer face of concrete frame at exterior walls, where flashing is shown at lintels, relieving angles, and other conditions.

- C. Edge Forms and Screed Strips for Slabs: Set edge forms or bulkheads and intermediate screed strips for slabs to obtain required elevations and contours in finished slab surface. Provide and secure units to support screed strips using strike-off templates or compacting type screeds.

3.7 PREPARATION OF FORM SURFACES

- A. Clean re-used forms of concrete matrix residue, repair and patch as required to return forms to acceptable surface condition.
- B. Coat contact surfaces of forms with an approved, nonresidual, low-VOC, form-coating compound before placing reinforcement.
- C. Thin form-coating compounds only with thinning agent of type, amount, and under conditions of form-coating compound manufacturer's directions. Do not allow excess form-coating material to accumulate in forms or to come into contact with in-place concrete surfaces against which fresh concrete will be placed. Apply in compliance with manufacturer's instructions.
- D. Coat steel forms with a non-staining, rust-preventative form oil or otherwise protect against rusting. Rust-stained steel form work is not acceptable.

3.8 CONCRETE PLACEMENT

- A. Preplacement Inspection: Before placing concrete, inspect and complete form work installation, reinforcing steel, and items to be embedded or cast-in. Notify other crafts to permit installation of their work; cooperate with other trades in setting such work. Moisten wood forms immediately before placing concrete where form coatings are not used.
 - 1. Apply temporary protective covering to lower 2' of finished walls adjacent to poured floor slabs and similar conditions, and guard against spattering during placement.
- B. General: Comply with ACI 304 "Recommended Practice for Measuring, Mixing, Transporting, and Placing Concrete," and as herein specified.
 - 1. Deposit concrete continuously or in layers of such thickness that no concrete will be placed on concrete which has hardened sufficiently to cause the formation of seams or planes of weakness. If a section cannot be placed continuously, provide construction joints as herein specified. Deposit concrete as nearly as practicable to its final location to avoid segregation.
- C. Placing Concrete in Forms: Deposit concrete in forms in horizontal layers not deeper than 24" and in a manner to avoid inclined construction joints. Where placement consists of several layers, place each layer while preceding layer is still plastic to avoid cold joints.

1. Consolidate placed concrete by mechanical vibrating equipment supplemented by hand-spading, rodding, or tamping. Use equipment and procedures for consolidation of concrete in accordance with ACI 309.
 2. Do not use vibrators to transport concrete inside forms. Insert and withdraw vibrators vertically at uniformly spaced locations not farther than visible effectiveness of machine. Place vibrators to rapidly penetrate placed layer and at least 6" into preceding layer. Do not insert vibrators into lower layers of concrete that have begun to set. At each insertion limit duration of vibration to time necessary to consolidate concrete and complete embedment of reinforcement and other embedded items without causing segregation of mix.
- D. Placing Concrete Slabs: Deposit and consolidate concrete slabs in a continuous operation, within limits of construction joints, until the placing of a panel or section is completed.
1. Consolidate concrete during placing operations so that concrete is thoroughly worked around reinforcement and other embedded items and into corners.
 2. Bring slab surfaces to correct level with straightedge and strikeoff. Use bull floats or darbies to smooth surface, free of humps or hollows. Do not disturb slab surfaces prior to beginning finishing operations.
 3. Maintain reinforcing in proper position on chairs during concrete placement operations.
- E. Cold Weather Placing: Protect concrete work from physical damage or reduced strength which could be caused by frost, freezing actions, or low temperatures, in compliance with ACI 306 and as herein specified.
1. When air temperature has fallen to or is expected to fall below 40 deg F (4 deg C), uniformly heat water and aggregates before mixing to obtain a concrete mixture temperature of not less than 50 deg F (10 deg C), and not more than 80 deg F (27 deg C) at point of placement.
 - a. The concrete shall be maintained within this temperature range for not less than seven (7) days.
 2. Do not use frozen materials or materials containing ice or snow. Do not place concrete on frozen subgrade or on subgrade containing frozen materials or against cold reinforcing steel.
 3. Do not use calcium chloride, salt, and other materials containing antifreeze agents or chemical accelerators, unless otherwise accepted in mix designs.
- F. Hot Weather Placing: When hot weather conditions exist that would seriously impair quality and strength of concrete, place concrete in compliance with ACI 305 and as herein specified.
1. Cool ingredients before mixing to maintain concrete temperature at time of placement below 90 deg F (32 deg C). Mixing water may be chilled, or chopped ice may be used to control temperature provided water equivalent of ice is calculated to

total amount of mixing water. Use of liquid nitrogen to cool concrete is Contractor's option.

2. Cover reinforcing steel with water-soaked burlap if it becomes too hot, so that steel temperature will not exceed the ambient air temperature immediately before embedment in concrete.
3. Fog spray forms, reinforcing steel, and subgrade just before concrete is placed.
4. Use water-reducing retarding admixture when required by high temperatures, low humidity, or other adverse placing conditions, as acceptable to Engineers.

3.9 FINISH OF FORMED SURFACES

- A. Rough Form Finish: For formed concrete surfaces not exposed-to-view in the finish work or by other construction, unless otherwise indicated. This is the concrete surface having texture imparted by form facing material used, with tie holes and defective areas repaired and patched and fins and other projections exceeding 1/4" in height rubbed down or chipped off.
- B. Smooth Form Finish: For formed concrete surfaces exposed-to-view, or that are to be covered with a coating material applied directly to concrete, or a covering material applied directly to concrete, such as waterproofing, dampproofing, veneer plaster, painting, or other similar system. This is an as-cast concrete surface obtained with selected form facing material, arranged orderly and symmetrically with a minimum of seams. Repair and patch defective areas with fins or other projections completely removed and smoothed; provide smooth rubbed finish to smooth form finish. Refer to "Concrete Surface Repairs."
- C. Smooth Rubbed Finish: Provide smooth rubbed finish to scheduled concrete surfaces, which have received smooth form finish treatment.
 1. Scarify or roughen entire surface by grinding or similar effective means.
 2. Combined one part Portland cement to 1-1/2 parts fine sand by volume and a 50:50 mixture of acrylic or styrene butadiene-based bonding admixture and water to form the consistency of thick paint. Blend standard Portland cement and white Portland cement, amounts determined by trial patches, so that final color of dry grout will match adjacent surfaces.
 3. Thoroughly wet concrete surfaces and apply grout to coat surfaces and fill small holes. Remove excess grout by scraping and rubbing with clean burlap. Keep damp by fog spray for at least 36 hours after rubbing.
 4. Repeat the above process if necessary to fill voids or bug holes and obtain a consistent match to adjacent surfaces, subject to acceptance of the Engineer.
- D. Grout Cleaned Finish: Provide grout cleaned finish on scheduled concrete surfaces which have received smooth form finish treatment.
 1. Scarify or roughen entire surface by grinding or similar effective means.
 2. Apply ThoroSeal plaster mix coating by Thoro System Products or approved equivalent with an approximate thickness of 1/8-inch to 1/4-inch.

3. Follow the manufacturer's recommendations and guidelines regarding surface preparation, application methods and curing.
 4. Repeat the above process if necessary to fill voids or bug holes and obtain a consistent match to adjacent surfaces, subject to acceptance of the Engineer.
- E. Related Unformed Surfaces: At tops of walls, horizontal offsets, and similar unformed surfaces occurring adjacent to formed surfaces, strike-off smooth and finish with a texture matching adjacent formed surfaces. Continue final surface treatment of formed surfaces uniformly across adjacent unformed surfaces, unless otherwise indicated.

3.10 MONOLITHIC SLAB FINISHES

- A. Scratch Finish: Apply scratch finish to monolithic slab surfaces that are to receive concrete floor topping or mortar setting beds for tile, Portland cement terrazzo, and other bonded applied cementitious finish flooring material, and as otherwise indicated.
1. After placing slabs, plane surface to tolerances for floor flatness F(F) 15 and floor levelness F(L) 13, measured according to ASTM E 1155. Slope surfaces uniformly to drains where required. After leveling, roughen surface before final set, with stiff brushes, brooms, or rakes.
- B. Float Finish: Apply float finish to monolithic slab surfaces to receive trowel finish and other finishes as hereinafter specified, and slab surfaces which are to be covered with membrane or elastic waterproofing, membrane or elastic roofing, or sand-bed terrazzo, and as otherwise indicated.
1. After screeding, consolidating, and leveling concrete slabs, do not work surface until ready for floating. Begin floating when surface water has disappeared or when concrete has stiffened sufficiently to permit operation of power-driven floats, or both, Consolidate surface with power-driven floats, or by hand-floating if area is small or inaccessible to power units. Check and level surface plane to tolerances of F(F) 18 F(L) 15. Cut down high spots and fill low spots. Uniformly slope surfaces to drains. Immediately after leveling, refloat surface to a uniform, smooth, granular texture.
- C. Trowel Finish: Apply trowel finish to monolithic slab surfaces to be exposed-to-view, and slab surfaces to be covered with resilient flooring, carpet, ceramic or quarry tile, paint, or other thin film finish coating system.
1. After floating, begin first trowel finish operation using a power-driven trowel. Begin final troweling when surface produces a ringing sound as trowel is moved over surface. Consolidate concrete surface by final hand-troweling operation, free of trowel marks, uniform in texture and appearance, and with surface leveled to tolerances of F(F), 20 and F(L) 17, measured according to ASTM E1155. Grind smooth surface defects which would telegraph through applied floor covering system.

- D. Trowel and Fine Broom Finish: Where ceramic or quarry tile is to be installed with thin-set mortar, apply trowel finish as specified, then immediately follow with slightly scarifying surface by fine brooming.
- E. Non-Slip Broom Finish: Apply non-slip broom finish to exterior concrete platforms, steps, and ramps, and elsewhere as indicated.
 - 1. Immediately after float finishing, slightly roughen concrete surface by brooming with fiber bristle broom perpendicular to main traffic route. Coordinate required final finish with Engineer before application.
- F. Non-slip Aggregate Finish: Apply non-slip aggregate finish to concrete stair treads, platforms, ramps, sloped walks, and elsewhere as indicated.
 - 1. After completion of float finishing, and before starting trowel finish, uniformly spread 25 lbs. of dampened non-slip aggregate per 100 sq. ft. of surface. Tamp aggregate flush with surface using a steel trowel, but do not force below surface. After broadcasting and tamping, apply trowel finishing as herein specified.
 - 2. After curing, lightly work surface with a steel wire brush, or an abrasive stone, and water to expose non-slip aggregate.
- G. Colored Wear-Resistant Finish: Provide colored wear-resistant finish to monolithic slab surface indicated.
 - 1. Apply dry shake materials for colored wear-resistant finish at rate of not less than 100 lbs. per 100 sq. ft., unless greater amount is recommended by material manufacturer.
 - 2. Immediately following first floating operation, uniformly distribute approximately 2/3 of required weight of dry shake material over concrete surface, and embed by means of power floating. Follow floating operation with second shake application, uniformly distributing remainder of dry shake material with overlapping applications, and embed by power floating.
 - 3. After completion of broadcasting and floating, apply trowel finish as herein specified. Cure slab surface with curing compound recommended by dry shake hardener manufacturer. Apply curing compound immediately after final finishing.

3.11 CONCRETE CURING AND PROTECTION

- A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures. Protect concrete from rapid moisture loss before and during finishing operations.
 - 1. The evaporation graph, Figure 1, of ACI 308 - Curing Concrete, shall be used to determine the evaporation rate during concrete placement. If the rate of evaporation equals or exceeds 0.2 lbs/sq.ft./hr., steps shall be taken to prevent excessive evaporation from the surface.
 - 2. Start initial curing as soon as free water has disappeared from concrete surface after placing and finishing.

- a. Initial curing may be any of the methods listed herein that maintain a satisfactory moisture content and temperature.
 3. Begin final curing procedures, if they differ from initial curing, immediately following initial curing and before concrete has dried. Continue curing for at least seven (7) days in accordance with ACI 301 procedures. Avoid rapid drying at end of final curing period.
- B. Curing Methods: Perform curing of all structural concrete as herein specified.
 1. Provide moisture curing by following methods.
 - a. Keep concrete surface continuously wet by covering with water.
 - b. Continuous water-fog spray.
 - c. Cover concrete surface with specified absorptive cover, thoroughly saturating cover with water and keeping continuously wet. Place absorptive cover to provide coverage of concrete surfaces and edges, with 4" lap over adjacent absorptive covers.
 2. Provide moisture-cover curing as follows:
 - a. Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width with sides and ends lapped at least 3" and sealed by waterproof tape or adhesive. Immediately repair any holes or tears during curing period using cover material and waterproof tape.
- C. Provide curing and sealing compound to pavement, walks, and curbs only, as follows:
 1. Apply specified curing and sealing compound to concrete slabs as soon as final finishing operations are complete (within 2 hours) and after surface water sheen has disappeared. Apply uniformly in continuous operation by power-spray or roller in accordance with manufacturer's directions. Recoat areas subjected to heavy rainfall within three (3) hours after initial application. Maintain continuity of coating and repair damage during curing period.
- D. Curing Formed Surfaces: Cure formed concrete surfaces, including undersides of beams, supported slabs, and other similar surfaces by moist curing with forms in place for full curing period or until forms are removed. If forms are removed, continue curing by methods specified above, as applicable.
- E. Curing Unformed Surfaces: Cure unformed surfaces, such as slabs, floor topping, and other flat surfaces by moist curing methods.
 1. Final cure concrete surfaces to receive liquid floor hardener or finish flooring by use of moisture-retaining cover, unless otherwise directed.

3.12 SHORES AND SUPPORTS

- A. Comply with ACI 347 for shoring and reshoring in multistory construction, and as herein specified.
- B. Extend shoring from ground to roof for structures four (4) stories or less, unless otherwise permitted.
- C. Extend shoring at least three (3) floors under floor or roof being placed for structures over four (4) stories. Shore floor directly under floor or roof being placed, so that loads from construction above will transfer directly to these shores. Space shoring in stories below this level in such a manner that no floor or member will be excessively loaded or will induce tensile stress in concrete members where no reinforcing steel is provided. Extend shores beyond minimums to ensure proper distribution of loads throughout structure.
- D. Remove shores and reshore in a planned sequence to avoid damage to partially cured concrete. Locate and provide adequate reshoring to safely support work without excessive stress or deflection.
 - 1. Keep reshores in place a minimum of 15 days after placing upper tier, and longer if required, until concrete has attained its required 28-day strength and heavy loads due to construction operations have been removed.

3.13 REMOVAL OF FORMS

- A. Formwork not supporting weight of concrete, such as sides of beams, walls, columns, and similar parts of the work, may be removed after cumulatively curing at not less than 50 deg F (10 deg C) for five (5) days after placing concrete, provided concrete is sufficiently hard to not be damaged by form removal operations, and provided curing and protection operations are maintained.
- B. Formwork supporting weight of concrete, such as beam soffits, joists, slabs, and other structural elements, may not be removed in less than 14 days or until concrete has attained at least 75 percent of design minimum compressive strength at 28 days. Determine potential compressive strength of in-place concrete by testing field-cured specimens representative of concrete location or members. Lab cured cylinders will not be considered.
- C. Form facing material may be removed five (5) days after placement, only if shores and other vertical supports have been arranged to permit removal of form facing material without loosening or disturbing shores and supports.

3.14 RE-USE OF FORMS

- A. Clean and repair surfaces of forms to be re-used in work. Split, frayed, delaminated, or otherwise damaged form facing material will not be acceptable for exposed surfaces. Apply new form coating compound as specified for new form work.
- B. When forms are extended for successive concrete placement, thoroughly clean surfaces, remove fins and laitance, and tighten forms to close joints. Align and secure joint to avoid offsets. Do not use "patched" forms for exposed concrete surfaces, except as acceptable to Engineer.

3.15 MISCELLANEOUS CONCRETE ITEMS

- A. Filling-In: Fill-in holes and openings left in concrete structures for passage of work by other trades, unless otherwise shown or directed, after work of other trades is in place. Mix, place, and cure concrete as herein specified, to blend with in-place construction. Provide other miscellaneous concrete filling shown or required to complete work.
- B. Curbs: Provide monolithic finish to interior curbs by stripping forms while concrete is still green and steel-troweling surfaces to a hard, dense finish with corners, intersections, and terminations slightly rounded.
- C. Equipment Bases and Foundations: Provide machine and equipment bases and foundations, as shown on drawings. Set anchor bolts for machines and equipment with template at correct elevations, complying with certified diagrams or templates of manufacturer furnishing machines and equipment.
 - 1. Grout base plates and foundations as indicated, using specified non-shrink grout. Use non-metallic grout for exposed conditions, unless otherwise indicated.
- D. Steel Pan Stairs: Provide concrete fill for steel pan stair treads and landings and associated items. Cast-in safety inserts and accessories as shown on drawings. Screed, tamp, and finish concrete surfaces as scheduled. Cure concrete as herein specified.
- E. Reinforced Masonry: Provide concrete grout conforming to ASTM C476 for reinforced masonry lintels and bond beams where indicated on drawings and as scheduled. Maintain accurate location of reinforcing steel during concrete placement.

3.16 CONCRETE SURFACE REPAIRS

- A. Patching Defective Areas: Repair and patch defective areas with cement mortar immediately after removal of forms, when acceptable to Engineer.
 - 1. Saw-cut out honeycomb, rock pockets, voids over 1/4" in any dimension, down to solid concrete but, in no case to a depth of less than 1." Make edges of cuts slightly undercut to the concrete surface. Thoroughly clean, dampen with water, and

- brush-coat the area to be patched with specified bonding agent. Place patching mortar after bonding compound has dried.
2. For exposed-to-view surfaces, blend white Portland cement and standard Portland cement so that, when dry, patching mortar will match surrounding color. Provide test areas at inconspicuous location to verify mixture and color match before proceeding with patching. Compact mortar in place and strike-off slightly higher than surrounding surface.
- B. Repair of Formed Surfaces: Remove and replace concrete having defective surfaces if defects cannot be repaired to satisfaction of Engineer. Surface defects, as such, include color and texture irregularities, cracks, spalls, air bubbles, honeycomb, rock pockets; fins and other projections on surface; and stains and other discolorations that cannot be removed by cleaning. Flush out form tie holes, fill with Portland Cement patching mortar, or precast cement cone plugs secured in place with bonding agent. When other materials are used, apply them in accordance with manufacturer's recommendations.
1. Repair concealed formed surfaces, where possible, that contain defects that affect the durability of concrete. If defects cannot be repaired, remove and replace concrete.
 2. Repair of Unformed Surfaces: Test unformed surfaces, such as monolithic slabs, for smoothness and verify surface plane to tolerances specified for each surface and finish. Correct low and high areas as herein specified. Test unformed surfaces sloped to drain for trueness of slope, in addition to smoothness using a template having required slope.
 3. Repair finished unformed surfaces that contain defects which affect durability of concrete. Surface defects, as such, include crazing, cracks in excess of 0.01" wide or which penetrate to reinforcement or completely through non-reinforced sections regardless of width, spalling, pop-outs, honeycomb, rock pockets, and other objectionable conditions.
 4. Correct high areas in unformed surfaces by grinding, after concrete has cured at least 14 days.
 5. Correct low areas in unformed surfaces during or immediately after completion of surface finishing operations by cutting out low areas and replacing with fresh concrete. Finish repaired areas to blend into adjacent concrete. Proprietary patching compounds may be used when acceptable to Engineer.
 6. Repair defective areas, except random cracks and single holes not exceeding 1" diameter, by cutting out and replacing with fresh concrete. Remove defective areas to sound concrete with clean, square cuts and expose reinforcing steel with at least 3/4" clearance all around. Dampen concrete surfaces in contact with patching concrete and apply bonding compound. Mix patching concrete of same materials to provide concrete of same type or class as original concrete. Place, compact, and finish to blend with adjacent finished concrete. Cure in same manner as adjacent concrete.
 7. Repair isolated random cracks and single holes not over 1" in diameter by dry-pack method. Groove top of cracks and cut-out holes to sound concrete and clean of dust, dirt, and loose particles. Dampen cleaned concrete surfaces and apply bonding

compound. Mix dry-pack, consisting of one part Portland cement to 2-1/2 parts fine aggregate passing a No. 16 mesh sieve, using only enough water as required for handling and placing. Place dry pack after bonding compound has dried. Compact dry-pack mixture in place and finish to match adjacent concrete. Keep patched area continuously moist for not less than 72 hours.

8. Perform structural repairs with prior approval of Engineer or Structural Engineer for method and procedure, using specified epoxy adhesive and mortar.
9. Repair methods not specified above may be used, subject to acceptance of Engineer.
10. Underlayment Application: Leveling of floors for subsequent finishes may be achieved by use of specified underlayment material.

3.17 THROUGH SECTION CONCRETE CRACK REPAIRS

A. Sealing through wall or slab cracks.

1. Seal cracks for a water-tight or structurally bonded repair with epoxy or chemical grouting procedures.
 - a. The Contractor shall make proper repairs with epoxy injection or chemical injection with a moisture reactive hydrophilic polyurethane foam grout, as directed by the Engineer.

3.18 MUD MATS

A. Where called for on the plans or as directed by the Engineer, the Contractor shall construct concrete mud mats immediately after cleaning the excavation bottom, to preserve the bearing surface condition. Concrete for mud mats shall be not less than 3 in. thick. Bottom of excavation shall be free of water, mud and loose material prior to mud mat placement. See Section 310000.

1. Mud mat concrete shall be cast against the side walls of all excavations to completely seal the bottom.

ADDENDUM
EXAMPLE FORM A

CONCRETE SUPPLIER: _____

PROJECT: _____ CONTRACTOR: _____

MIXTURE ID: _____ SPECIFIED f'_c : _____ PSI

MATERIAL

MIXTURE PROPORTIONS lbs-mass/cu.yd. (pcy)

1.0 Cement Type _____ Source: _____

Sp. Gr. _____ pcy _____ cu. ft.

1.1 Other Cementitious Materials: _____ Class: _____ Source: _____

Sp. Gr. _____ pcy _____ cu. ft.

2.0 Aggregate (No. 1) Type: _____ Size: _____ Source: _____

SSD Sp. Gr. _____ pcy _____ cu. ft.

Dry Rodded Unit Wt.: _____ pcf

Alternate (No. 1) Lightweight Aggregate Type: _____ Size: _____ Source: _____

Sp. Gr. Factor _____ over dry pcy _____ cu. ft.

Loose Unit Wt. _____ pcf Estimated Wet _____ pcf

2.1 Aggregate (No. 2) Type: _____ Size: _____ Source: _____

SSD Sp. Gr. _____ pcy _____ cu. ft.

Dry Rodded Unit Wt.: _____ pcf (If Fine Sized - FM _____)

2.2 Aggregate (Nos. 3, 4, n) Type: _____ Size: _____ Source: _____

SSD Sp. Gr. _____ pcy _____ cu. ft.

Dry Rodded Unit Wt.: _____ pcf

3.0 Water: _____ gal. _____ pcy _____ cu. ft.

EXAMPLE FORM A (CONTINUED)

4.0 Admixtures expressed as fluid ounces/cubic yard, and estimated range

Source: _____ Name: _____ Type _____ oz

Source: _____ Name: _____ Type _____ oz

Source: _____ Name: _____ Type _____ oz

Total Admixture Liquid Vol. _____ cu. ft.

(*) Note: Show volume in 4.0 if not included in cubic feet of air or water.

5.0 Other Materials - fibers, color pigment or other additions

Sp. Gr. _____ pcy _____ cu. ft.

Total Mixture Mass and Volume: _____ pcy _____ cu. ft.

Fresh Concrete Properties

Coarse & Fine Aggregate Gradation

Percent Passing

Slump _____ +/- _____ in.

Sieve Size

Aggregate No.

Unit Weight _____ pcf

2 in.

1 2 3 4 Combined

Air Content _____ +/- _____ %

1-1/2 in. _____

1 in.

3/4 in.

1/2 in.

If Trail Batch Data -

3/8 in.

Identify Batch No. _____

No. 4

Batch Date _____

No. 8

Concrete Temp. _____ °F

No. 16

Comp. Strength-Average _____ °F

No. 30

EXAMPLE FORM A (CONTINUED)

7 day avg. _____psi

No. 50 _____

28 day avg. _____psi

No. 100 _____

No. 200 _____

Comments: _____

Signature: _____ Date: _____

Title: _____

Organization: _____

EXAMPLE FORM B

CONCRETE SUPPLIER: _____

MATERIAL

TRAIL BATCH NUMBER - proportions per cubic yard

1 2 3 4

1.0 Cement Source: _____

Type _____ lb _____ lb _____ lb _____ lb

1.1 Other Cementitious Material Sources: _____

Type _____ lb _____ lb _____ lb _____ lb

2.0 Aggregate No. 1 Size _____ Source: _____

SSD _____ lb _____ lb _____ lb _____ lb

Alternate No. 1 Lightweight Aggregates Type _____ Source: _____

Sp. Gr. Factor _____

Oven Dry _____ lb _____ lb _____ lb _____ lb

Wet _____ lb _____ lb _____ lb _____ lb

2.1 Aggregate No. 2 Size _____ Source: _____

SSD _____ lb _____ lb _____ lb _____ lb

2.2 Aggregate Nos. 3, 4, n) Size _____ Source: _____

SSD _____ lb _____ lb _____ lb _____ lb

3.0 Water _____ lb _____ lb _____ lb _____ lb

4.0 Admixtures Source: _____

_____ Type _____ oz _____ oz _____ oz _____ oz

_____ Type _____ oz _____ oz _____ oz _____ oz

_____ Type _____ oz _____ oz _____ oz _____ oz

EXAMPLE FORM B (CONTINUED)

5.0 Other Materials

_____ Type _____ _____lb _____lb _____lb _____lb

Total Mass: _____lb _____lb _____lb _____lb

Total Mass/cy: _____pcy _____pcy _____pcy _____pcy

Relative Cubic Yard Volume:
 _____cy _____cy _____cy _____cy

Water-Cementitious Material Ratio:

Fresh Concrete Properties

TRAIL BATCH NUMBER

	<u>## -1</u>	<u>## -2</u>	<u>## -3</u>	<u>## -4</u>
Slump-inches	_____	_____	_____	_____
Air-Content %	_____	_____	_____	_____
Unit Wt. pcf	_____	_____	_____	_____
Concrete Temp. °F	_____	_____	_____	_____
Compressive Strength Results (ASTM C192, C39) or Other Specified Test Requirements				
7 days	_____	_____	_____	_____
	_____	_____	_____	_____
	_____	_____	_____	_____
Average (7 day)	_____	_____	_____	_____

EXAMPLE FORM B (CONTINUED)

28 days	_____	_____	_____	_____
	_____	_____	_____	_____
	_____	_____	_____	_____
Average (28 day)	_____	_____	_____	_____
Water-Cementitious Material Ratio:	_____	_____	_____	_____

Signature: _____ Date: _____

Title: _____

Organization: _____

END OF SECTION 030000

SECTION 030000.02 - EXPANSION AND CONSTRUCTION JOINTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to the work of this section.

1.2 DESCRIPTION OF WORK

- A. This work includes furnishing and installing all joints where necessary.
- B. In general, the work may include the following types of joints:
 - 1. Type A, D, E, F, H and J Expansion Joints
 - 2. Types B and L Waterstop Construction Joints
 - 3. Types C and G Isolation Joints
 - 4. Type K Construction Joint
 - 5. Type CJ Contraction Joint
- C. Refer to the contract drawings and specifications for locations and details of the joints to be used. Not all joint types may be used.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. The non-extruding preformed filler for joint Types A, C, D, E, F, J, L, and M shall conform to the requirements of "Standard Specifications for Preformed Sponge Rubber and Cork Expansion Joint Fillers for Concrete Paving and Structural Construction" ASTM D 1752, Type I, Sponge Rubber. Preformed filler shall be "Sponge Rubber" as manufactured by W.R. Meadows Company, Everlastic 1300 Series concrete gray sponge by Williams Products, Inc. or equal.
- B. The preformed filler for joint Type H shall conform to the requirements of ASTM D 1752, Type III, self-expanding cork. Self-expanding cork shall be as manufactured by W.R. Meadows Company, or equal.
- C. Preformed filler strips up to one (1) inch thickness shall be made as a single piece. Strips greater than one (1) inch thickness shall be fabricated by cementing together a minimum number of pieces. All cementing or vulcanizing shall be done at the point of manufacture.
- D. The joint sealer shall be cold applied in accordance with manufacturer's recommendations.
 - 1. Where the joint is not in contact with water, "No-Trak" as manufactured by A.C. Horn, Inc., "Gardox" by W.R. Meadows, Inc., or equal, shall be used.

2. Where the joint is in contact with water, "Sikaflex-IA" as manufactured by Sika Corporation, or equal shall be used.
- E. Extruded polyvinyl chloride (PVC) waterstops for Type "C" joint shall be nine (9) inches in width, not less than three-eighths (3/8) inch in thickness; Type "L" joint shall be four (4) inches wide, not less than three-sixteenths (3/16) inch in thickness; Types "G" and "J" joint shall be six (6) inches in width, not less than three-eighths (3/8) inch in thickness and all waterstops shall be of corrugated construction. Types "C," "G," and "J" shall have a center bulb and corrugated ends. The waterstops shall be made continuous by use of factory made fittings and field jointing by heat welding in accordance with the manufacturer's recommendations. PVC waterstops shall be as manufactured by Vinylex Corporation, Greenstreak Products, or equal. Provide a test report for each lot of waterstops shipped to the job site.
- F. Type "B" joints shall be as detailed on the drawings. The preformed plastic waterstops shall meet or exceed all requirements of Federal Specifications SS-S-210A, "Sealing Compound for Expansion Joints". Such preformed plastic waterstop shall be "Snyko-Flex" waterstop manufactured by Synko-Flex Products, 2100 Travis Street, Houston, Texas, or an approved equivalent.
- G. Elastomeric bearing pad in joint Type "G" shall be 50 durometer Everlastic 1200 Series Neoprene as manufactured by William Products, Inc., or equal.
- H. Type "K" joint shall be constructed as detailed on the drawings.
- I. Type "CJ" premolded insert shall be "Speed-E-Joint" by W.R. Meadows, or equal.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Form work shall be designed to hold the preformed filler in alignment within the joint during and after concrete is poured. General description of the joints are as follows:
 1. Type "A", "D", "E" and "F" expansion joints shall consist of non-extruding preformed filler only to separate the adjoining faces of concrete without the use of a waterstop. The top shall be finished by a joint sealer for slabs. Unless otherwise shown, preformed filler shall be three-fourths (3/4) inch thick and shall be of a width equal to the faces of concrete which it is separating. Where required, the preformed filler shall be attached to concrete by the use of an approved adhesive. Apply bond breaker to edge of preformed filler material only, prior to placing joint sealer. The joint sealer shall bond only to the concrete surfaces.
 2. Type "B" waterstop construction joint shall consist of a standard construction joint and waterstop as detailed on the drawings.
 3. Types "C" and "J" joint shall consist of preformed filler material, waterstop and joint sealer as detailed on the drawings.
 4. Type "G" joint shall consist of an elastomeric bearing pad and waterstop as detailed on the drawings.

5. Type "H" joint shall consist of self-expanding cork to separate the adjoining faces of concrete without the use of a waterstop. The top shall be finished by a joint sealer.
 6. Type "CJ" Control joints shall be made by inserting a removable preformed insert to create a joint which is then filled with a joint sealer, if required.
 7. Type "K" joint shall consist of a standard construction joint, a saw cut, and joint sealer as detailed on the drawings.
- B. PVC waterstops shall be wired to the reinforcing steel every 12" to prevent misalignment during concreting.

END OF SECTION 030000.02

SECTION 031000 - CONCRETE FORMING AND ACCESSORIES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Form-facing materials.
 - 2. Waterstops.

1.2 DEFINITIONS

- A. Form-Facing Material: The temporary form materials that come in direct contact with the concrete as part of the formwork components in supporting the concrete while the concrete is setting and gaining sufficient strength to be self-supporting. The most common materials are steel, aluminum, and wood.
- B. Formwork: The total system of support of freshly placed concrete, including the mold or sheathing that contacts the concrete, as well as supporting members, hardware, and necessary bracing.

1.3 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.
 - 1. Review the following:
 - a. Special inspection and testing and inspecting agency procedures for field quality control.
 - b. Construction, movement, contraction, and isolation joints
 - c. Forms and form-removal limitations.
 - d. Shoring and reshoring procedures.
 - e. Anchor rod and anchorage device installation tolerances.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: Prepared by, and signed and sealed by, a qualified professional engineer responsible for their preparation, detailing fabrication, assembly, and support of forms.
 - 1. For exposed vertical concrete walls, indicate dimensions and form tie locations.

2. Indicate dimension and locations of construction and movement joints required to construct the structure in accordance with ACI 301.
 - a. Location of construction joints is subject to approval of Architect.
3. Indicate location of waterstops.
4. Indicate proposed schedule and sequence of stripping of forms, shoring removal, and reshoring installation and removal.
5. Indicate layout of insulating concrete forms, dimensions, course heights, form types, and details.

C. Samples:

1. For waterstops.

1.5 INFORMATIONAL SUBMITTALS

- A. Research Reports: For insulating concrete forms indicating compliance with ICC's Acceptance Criteria AC353.
- B. Field quality-control reports.
- C. Minutes of preinstallation conference.
- D. Qualification Statements: For testing and inspection agency.

1.6 QUALITY ASSURANCE

- A. Testing and Inspection Agency Qualifications: An independent agency qualified in accordance with ASTM C1077 and ASTM E329 for testing indicated.
- B. Mockups: Formed surfaces to demonstrate typical joints, surface finish, texture, tolerances, and standard of workmanship.
 1. Subject to compliance with requirements, approved mockups may become part of the completed Work.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Waterstops: Store waterstops under cover to protect from moisture, sunlight, dirt, oil, and other contaminants.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Concrete Formwork: Design, engineer, erect, shore, brace, and maintain formwork, shores, and reshores in accordance with ACI 301, to support vertical, lateral, static, and dynamic loads, and construction loads that might be applied, until structure can support such loads, so that resulting concrete conforms to the required shapes, lines, and dimensions.
1. Design wood panel forms in accordance with APA's "Concrete Forming Design/Construction Guide."
 2. Design formwork to limit deflection of form-facing material to 1/240 of center-to-center spacing of supports.
 - a. For architectural concrete specified in Section 033300 "Architectural Concrete," limit deflection of form-facing material, studs, and walers to 0.0025 times their respective clear spans (L/400).
- B. Design, engineer, erect, shore, brace, and maintain insulating concrete forms in accordance with ACI 301, to support vertical, lateral, static, and dynamic loads, and construction loads that might be applied, until structure can support such loads, so that resulting concrete conforms to the required shapes, lines, and dimensions.
1. Design cross ties to transfer the effects of the following loads to the cast-in-place concrete core:
 - a. Wind Loads: As indicated on Drawings.

2.2 FORM-FACING MATERIALS

- A. As-Cast Surface Form-Facing Material:
1. Provide continuous, true, and smooth concrete surfaces.
 2. Furnish in largest practicable sizes to minimize number of joints.
 3. Acceptable Materials: As required to comply with Surface Finish designations specified in Section 033000 "Cast-in-Place Concrete, and as follows:
 - a. Plywood, metal, or other approved panel materials.
 - b. Exterior-grade plywood panels, suitable for concrete forms, complying with DOC PS 1, and as follows:
 - 1) APA HDO (high-density overlay).
 - 2) APA MDO (medium-density overlay); mill-release agent treated and edge sealed.
 - 3) APA Structural 1 Plyform, B-B or better; mill oiled and edge sealed.
 - 4) APA Plyform Class I, B-B or better; mill oiled and edge sealed.

- B. Concealed Surface Form-Facing Material: Lumber, plywood, metal, plastic, or another approved material.
 - 1. Provide lumber dressed on at least two edges and one side for tight fit.
- C. Void Forms: Biodegradable paper surface, treated for moisture resistance, structurally sufficient to support weight of plastic concrete and other superimposed loads.

2.3 RELATED MATERIALS

- A. Reglets: Fabricate reglets of not less than 0.022-inch- thick, galvanized-steel sheet. Temporarily fill or cover face opening of reglet to prevent intrusion of concrete or debris.
- B. Dovetail Anchor Slots: Hot-dip galvanized-steel sheet, not less than 0.034 inch thick, with bent tab anchors. Temporarily fill or cover face opening of slots to prevent intrusion of concrete or debris.
- C. Chamfer Strips: Wood, metal, PVC, or rubber strips, 3/4 by 3/4 inch, minimum.
- D. Rustication Strips: Wood, metal, PVC, or rubber strips, kerfed for ease of form removal.
- E. Form-Release Agent: Commercially formulated form-release agent that does not bond with, stain, or adversely affect concrete surfaces and does not impair subsequent treatments of concrete surfaces.
 - 1. Formulate form-release agent with rust inhibitor for steel form-facing materials.
 - 2. Form release agent for form liners to be acceptable to form liner manufacturer.
- F. Form Ties: Factory-fabricated, removable or snap-off, glass-fiber-reinforced plastic or metal form ties designed to resist lateral pressure of fresh concrete on forms and to prevent spalling of concrete on removal.
 - 1. Furnish units that leave no corrodible metal closer than 1 inch to the plane of exposed concrete surface.
 - 2. Furnish ties that, when removed, leave holes no larger than 1 inch in diameter in concrete surface.
 - 3. Furnish ties with integral water-barrier plates to walls indicated to receive dampproofing or waterproofing.
- G. Sealant: One-part moisture cure silicone sealant used with form liners.

PART 3 - EXECUTION

3.1 INSTALLATION OF FORMWORK

- A. Comply with ACI 301.
- B. Construct formwork, so concrete members and structures are of size, shape, alignment, elevation, and position indicated, within tolerance limits of ACI 117 and to comply with the Surface Finish designations specified in Section 033000 "Cast-in-Place Concrete" for as-cast finishes.
- C. Limit concrete surface irregularities as follows:
 - 1. Surface Finish-1.0: ACI 117 Class D, 1 inch.
 - 2. Surface Finish-2.0: ACI 117 Class B, 1/4 inch.
 - 3. Surface Finish-3.0: ACI 117 Class A, 1/8 inch.
- D. Construct forms tight enough to prevent loss of concrete mortar.
 - 1. Minimize joints.
 - 2. Exposed Concrete: Symmetrically align joints in forms.
- E. Construct removable forms for easy removal without hammering or prying against concrete surfaces.
 - 1. Provide crush or wrecking plates where stripping may damage cast-concrete surfaces.
 - 2. Provide top forms for inclined surfaces steeper than 1.5 horizontal to 1 vertical.
 - 3. Install keyways, reglets, recesses, and other accessories, for easy removal.
- F. Do not use rust-stained, steel, form-facing material.
- G. Set edge forms, bulkheads, and intermediate screed strips for slabs to achieve required elevations and slopes in finished concrete surfaces.
 - 1. Provide and secure units to support screed strips
 - 2. Use strike-off templates or compacting-type screeds.
- H. Provide temporary openings for cleanouts and inspection ports where interior area of formwork is inaccessible.
 - 1. Close openings with panels tightly fitted to forms and securely braced to prevent loss of concrete mortar.
 - 2. Locate temporary openings in forms at inconspicuous locations.
- I. Chamfer exterior corners and edges of permanently exposed concrete.

- J. At construction joints, overlap forms onto previously placed concrete not less than 12 inches.
- K. Form openings, chases, offsets, sinkages, keyways, reglets, blocking, screeds, and bulkheads required in the Work.
 - 1. Determine sizes and locations from trades providing such items.
 - 2. Obtain written approval of Architect prior to forming openings not indicated on Drawings.
- L. Form Liners: Install per manufacturer's written installation instructions and recommended tolerances.
- M. Construction and Movement Joints:
 - 1. Construct joints true to line with faces perpendicular to surface plane of concrete.
 - 2. Install so strength and appearance of concrete are not impaired, at locations indicated or as approved by Architect.
 - 3. Place joints perpendicular to main reinforcement.
 - 4. Locate joints for beams, slabs, joists, and girders in the middle third of spans.
 - a. Offset joints in girders a minimum distance of twice the beam width from a beam-girder intersection.
 - 5. Locate horizontal joints in walls and columns at underside of floors, slabs, beams, and girders and at the top of footings or floor slabs.
 - 6. Space vertical joints in walls as indicated on Drawings.
 - a. Locate joints beside piers integral with walls, near corners, and in concealed locations where possible.
- N. Provide temporary ports or openings in formwork where required to facilitate cleaning and inspection.
 - 1. Locate ports and openings in bottom of vertical forms, in inconspicuous location, to allow flushing water to drain.
 - 2. Close temporary ports and openings with tight-fitting panels, flush with inside face of form, and neatly fitted, so joints will not be apparent in exposed concrete surfaces.
- O. Clean forms and adjacent surfaces to receive concrete. Remove chips, wood, sawdust, dirt, and other debris just before placing concrete.
- P. Retighten forms and bracing before placing concrete, as required, to prevent mortar leaks and maintain proper alignment.
- Q. Coat contact surfaces of forms with form-release agent, in accordance with manufacturer's written instructions, before placing reinforcement.

3.2 INSTALLATION OF EMBEDDED ITEMS

- A. Place and secure anchorage devices and other embedded items required for adjoining work that is attached to or supported by cast-in-place concrete.
 - 1. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 - 2. Install anchor rods, accurately located, to elevations required and complying with tolerances in Section 7.5 of AISC 303.
 - 3. Install reglets to receive waterproofing and to receive through-wall flashings in outer face of concrete frame at exterior walls, where flashing is shown at lintels, shelf angles, and other conditions.
 - 4. Install dovetail anchor slots in concrete structures, as indicated on Drawings.
 - 5. Clean embedded items immediately prior to concrete placement.

3.3 INSTALLATION OF WATERSTOPS

- A. Flexible Waterstops: Install in construction joints and at other joints indicated to form a continuous diaphragm.
 - 1. Install in longest lengths practicable.
 - 2. Locate waterstops in center of joint unless otherwise indicated on Drawings.
 - 3. Allow clearance between waterstop and reinforcing steel of not less than 2 times the largest concrete aggregate size specified in Section 033000 "Cast-in-Place Concrete."
 - 4. Secure waterstops in correct position at 12 inches o.c.
 - 5. Field fabricate joints in accordance with manufacturer's written instructions using heat welding.
 - 6. Clean waterstops immediately prior to placement of concrete.
 - 7. Support and protect exposed waterstops during progress of the Work.

3.4 REMOVING AND REUSING FORMS

- A. Formwork for sides of beams, walls, columns, and similar parts of the Work that does not support weight of concrete may be removed after cumulatively curing at not less than 50 deg F for 24 hours after placing concrete. Concrete has to be hard enough to not be damaged by form-removal operations, and curing and protection operations need to be maintained.
 - 1. Leave formwork for beam soffits, joists, slabs, and other structural elements that support weight of concrete in place until concrete has achieved at least 70 percent of its 28-day design compressive strength.
 - 2. Remove forms only if shores have been arranged to permit removal of forms without loosening or disturbing shores.
- B. Clean and repair surfaces of forms to be reused in the Work.

1. Split, frayed, delaminated, or otherwise damaged form-facing material are unacceptable for exposed surfaces.
 2. Apply new form-release agent.
- C. When forms are reused, clean surfaces, remove fins and laitance, and tighten to close joints.
1. Align and secure joints to avoid offsets.
 2. Do not use patched forms for exposed concrete surfaces unless approved by Architect.

3.5 INSTALLATION OF SHORING AND RESHORING

- A. Comply with ACI 318 and ACI 301 for design, installation, and removal of shoring and reshoring.
1. Do not remove shoring or reshoring until measurement of slab tolerances is complete.
- B. In multistory construction, extend shoring or reshoring over a sufficient number of stories to distribute loads in such a manner that no floor or member will be excessively loaded or will induce tensile stress in concrete members without sufficient steel reinforcement.
- C. Plan sequence of removal of shores and reshore to avoid damage to concrete. Locate and provide adequate reshoring to support construction without excessive stress or deflection.

3.6 FIELD QUALITY CONTROL

- A. Special Inspections: Owner will engage a qualified testing and inspecting agency to perform field tests and inspections and prepare test reports.
- B. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- C. Inspections:
1. Inspect formwork for shape, location, and dimensions of the concrete member being formed.
 2. Inspect insulating concrete forms for shape, location, and dimensions of the concrete member being formed.
- D. Prepare test and inspection reports.

END OF SECTION 031000

SECTION 034113 - PRECAST CONCRETE HOLLOW CORE PLANKS

PART 1- GENERAL

1.1 DESCRIPTION

- A. Work Included: All labor and materials required to design, furnish and install the precast concrete decking units indicated on the Drawings. Include all weld plates, headers, bearing pads, and other accessories as required for a complete installation.
- B. Related Work Specified Elsewhere: The general provisions of the Contract apply to the work of this Section, as though reproduced herein. Carefully examine all other Sections and all Drawings for related work.
- C. Testing required by this Section is to be at the Contractor's expense.

1.2 QUALITY ASSURANCE

- A. All precast concrete hollow core plank construction shall conform with the governing codes including the latest adopted editions of the standards and material specifications referenced herein.
- B. Reference Standards:
 - 1. By the American Concrete Institute (ACI):
 - a. ACI 318, Building Code Requirements for Structural Concrete.
 - b. ACI 301, Specifications for Structural Concrete.
 - 2. By the Prestressed Concrete Institute (PCI):
 - a. PCI MNL 116, Manual for Quality Control for Plants and Production of Structural Concrete Products.
 - b. PCI MNL 120, PCI Design Handbook - Precast Prestressed Concrete.
- C. Fire Resistance: Where indicated, provide structural precast slab units whose fire resistance meets the prescriptive requirements of the governing code or has been calculated according to PCI MNL 124, Design for Fire Resistance of Precast Prestressed Concrete and is acceptable to authorities having jurisdiction.
- D. Acceptable Manufacturers: Minimum of five years' production experience in work of the quality and scope required for this project. Manufacturing procedures shall comply with PCI MNL 116.
- E. Comply with the testing provisions in PCI MNL 116.
- F. Welders Qualifications: Personnel and procedures are to be qualified per the requirements of the American Welding Society, AWS D1.1 "Structural Welding Code-Steel" for the type of welding to be performed.

1.3 SUBMITTALS

- A. Erection Shop Drawings:
 - 1. Contents:
 - a. Plans which locate and define all material furnished, including manufacturer's standard slab designations.
 - b. Sections and details, showing connections, cast-in-place items, and their relation to the structure.
 - c. Description of all loose, cast-in-place items, and field hardware.
 - d. All dead, live, and other applicable loads used in the design.
 - e. Reinforcement.
 - f. Show all dimensions, sizes and locations of openings, including headers where required.
 - 2. Show location of each unit by same identification mark placed on the unit.
 - 3. Indicate compliance with fire rating requirements.
 - 4. Submit Shop Drawings stamped with seal of professional engineer registered in the state of the project.
- B. The manufacturer's standard published literature and load tables.
- C. Calculations: Submit for special units not covered by standard load tables.
- D. Test Reports: Submit, on request only, certificates of materials' compliance with Specifications, concrete mix designs, and compressive strength tests.

1.4 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. Comply with the manufacturer's recommended procedures.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Portland Cement: ASTM C150, Type I or III.
- B. Flyash: ASTM C618, Class F.
- C. Aggregates: ASTM C33.
- D. Admixtures: Do not use calcium chloride or admixtures containing significant amounts of calcium chloride.
 - 1. Air Entraining: ASTM C260.
 - 2. Water-Reducing: ASTM C494, Type A or D.

3. Superplasticizer ASTM C494, Type F or G.
- E. Water: Potable, free of foreign materials in amounts harmful to concrete.
- F. Reinforcing Steel:
 1. Deformed Bars: ASTM A615, grade 60.
 2. Tendons: ASTM A416, grade 250 (minimum requirements).
- G. Structural Steel Shapes and Plates: ASTM A36.
- H. Welded Headed Studs: ASTM A108, grade 1010 through 1020, AWS D1.1-Type A or B.
- I. Bearing Strips: Tempered hardboard, 1/8 inch thick, Masonite or equal, or high density plastic, 1/8 inch thick, Korolath or equal.
- J. Grout: Portland cement, sand, and sufficient water for placement and hydration. Maximum sand:cement ratio to be 2.5:1. Grout strength to be 3,000 psi at 28 days.
- K. Caulk: Non-shrinking, non-staining thermo-plastic putty, per Division 7.

2.2 MIXES

- A. Compressive strength at 28 days to be 5,000 psi minimum.
- B. Compressive strength at release to be 3,500 psi minimum.
- C. The use of a water-reducing admixture is optional.

2.3 DESIGN CRITERIA

- A. In general, comply with ACI 318 and PCI MNL 120.
- B. Design units to resist all stresses induced by handling and erection, in addition to those induced by the design superimposed loads indicated on the Drawings.
- C. Final design of members and connections is to be by professional engineer, registered in the state of the project, experienced in similar design, retained by the manufacturer. Provide sealed Drawings verifying compliance.

2.4 FABRICATION

- A. General: Manufacturing practices shall comply with PCI MNL 116.
- B. Manufacturing tolerances shall comply with PCI MNL 116.
- C. Cover:

1. Provide 3/4-inch minimum cover for reinforcing steel.
2. Provide cast-in-place anchors, inserts, etc., with sufficient anchorage and embedment for design requirements.

PART 3 - EXECUTION

3.1 SURFACE CONDITIONS

- A. Verify that structure and anchorage inserts are in place and within tolerance, prior to erecting units.
- B. Verify that bearing surfaces are smooth and level.
- C. Determine field conditions by actual measurements.

3.2 ERECTION

- A. Set bearing strips where required, smooth side up.
- B. Set units level and square, keeping units tight and in proper alignment with supports.
- C. Cooperate with other trades in permitting insertion of anchors, hangers, electrical outlets, etc.
- D. Weld to supports, as shown on the Drawings.

3.3 GROUTING

- A. Between Slab Edges: Fill grout key full and strike off flush with top surface. Remove any grout which seeps through to underside of units before it hardens. Clean excess from faces of supports and floors below.
- B. At Slab Ends: Where end grouting is shown on the Drawings, provide suitable end cap or dam in voids.

3.4 HOLES AND OPENINGS

- A. Holes and openings not requiring cutting of tendons are to be field cut, per the manufacturer's directions, in hollow cores of unit.
- B. Holes and openings requiring cutting of tendons are to be located prior to casting units. The manufacturer is to design and provide necessary additional reinforcing, in unit with opening and in adjacent units. Do not cut reinforcing or prestressing strands without approval of the manufacturer and the project structural engineer.

- C. All openings larger than one slab width are to be framed with concrete or structural steel headers. Adjacent units to be designed to support additional load.
- D. Cut no tendons without approval of the manufacturer and the Architect.

3.5 PATCHING

- A. Small surface imperfections caused by air bubbles, form joints, and minor chips and spalls need not be patched.
- B. Major unsightly imperfections, honeycombing, or structural defects will be cause for rejection of the unit. At the discretion of the Architect, such units may be accepted after repair.

3.6 CLEANING

- A. After installation, clean soiled concrete surfaces by washing and brushing using water, fiber brush and sponge. Rinse thoroughly with clean water.
- B. Use approved concrete detergent if washing and brushing fails to achieve the desired appearance. Use extreme care to prevent damage to concrete surfaces and adjacent materials.

3.7 CAULKING

- A. Apply uniformly where underside is to be painted, using no more than necessary to fill the joints. Smooth with finger, leaving 1/8-inch depression.

3.8 FIELD QUALITY CONTROL

- A. Testing agency to be the same agency retained under Section 051200 "Structural Steel."
- B. Field welds will be visually inspected.
- C. Testing agency shall submit test reports promptly to the Architect and Contractor.
- D. Correct deficiencies in the work that inspections and test reports have indicated are not in compliance with specified requirements. Additional testing will be required to determine compliance of corrected work.

END OF SECTION

SECTION 040110 - MASONRY CLEANING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification Sections, apply to work of this section.

1.2 SUMMARY

- A. Work in this Section applies solely to the renovation and improvements to the Administration/Operations Building (Building #1).
- B. Section includes cleaning the following:
 - 1. Unit masonry surfaces.

1.3 DEFINITIONS

- A. Very Low-Pressure Spray: Under 100 psi.
- B. Low-Pressure Spray: 100 to 400 psi.

1.4 SEQUENCING AND SCHEDULING

- A. Work Sequence: Perform masonry-cleaning work in the following sequence:
 - 1. Inspect for open mortar joints. Where repairs are required, delay further cleaning work until after repairs are completed, cured, and dried to prevent the intrusion of water and other cleaning materials into the wall.
 - 2. Clean masonry surfaces.
- B. Patch holes in masonry units according to masonry repair Sections. Patch holes in mortar joints according to masonry repointing Sections.

1.5 QUALITY ASSURANCE

- A. Cleaning Program: Prepare a written cleaning program that describes cleaning process in detail, including materials, methods, and equipment to be used; protection of surrounding materials; and control of runoff during operations. Include provisions for supervising worker performance and preventing damage.
 - 1. If materials and methods other than those indicated are proposed for any phase of cleaning work, add a written description of such materials and methods, including evidence of successful use on comparable projects and demonstrations to show their effectiveness for this Project.

1.6 FIELD CONDITIONS

- A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit masonry-cleaning work to be performed according to product manufacturers' written instructions and specified requirements.
- B. Clean masonry surfaces only when air temperature is 40 deg F and above and is predicted to remain so for at least seven days after completion of cleaning.

PART 2 - PRODUCTS

2.1 CLEANING MATERIALS

- A. Water: Potable.
- B. Hot Water: Water heated to a temperature of 140 to 160 deg F.
- C. Detergent Solution, Job Mixed: Solution prepared by mixing 2 cups of tetrasodium pyrophosphate (TSPP), 1/2 cup of laundry detergent, and 20 quarts of hot water for every 5 gal. of solution required.
- D. Mold, Mildew, and Algae Remover, Job Mixed: Solution prepared by mixing 2 cups of tetrasodium pyrophosphate (TSPP), 5 quarts of 5 percent sodium hypochlorite (bleach), and 15 quarts of hot water for every 5 gal. of solution required.

PART 3 - EXECUTION

3.1 PROTECTION

- A. Remove downspouts and associated hardware adjacent to immediate work area, where practical, and store during masonry cleaning. Reinstall when masonry cleaning is complete.
 - 1. Provide temporary rain drainage during work to direct water away from building.

3.2 CLEANING MASONRY, GENERAL

- A. Proceed with cleaning in an orderly manner; work from top to bottom of each scaffold width and from one end of each elevation to the other. Ensure that dirty residues and rinse water do not wash over dry, cleaned surfaces.
- B. Use only those cleaning methods indicated for each masonry material and location.
 - 1. Brushes: Do not use wire brushes or brushes that are not resistant to chemical cleaner being used.
 - 2. Spray Equipment: Use spray equipment that provides controlled application at volume and pressure indicated, measured at nozzle. Adjust pressure and volume to ensure that cleaning methods do not damage surfaces, including joints.

- a. Equip units with pressure gages.
 - b. For water-spray application, use fan-shaped spray that disperses water at an angle of 25 to 50 degrees.
 - c. For heated water-spray application, use equipment capable of maintaining temperature between 140 and 160 deg F at flow rates indicated.
- C. Perform each cleaning method indicated in a manner that results in uniform coverage of all surfaces, including corners, moldings, and interstices, and that produces an even effect without streaking or damaging masonry surfaces. Keep wall wet below area being cleaned to prevent streaking from runoff.
- D. Perform additional general cleaning, paint and stain removal, and spot cleaning of small areas that are noticeably different when viewed according to the "Cleaning Appearance Standard" Paragraph, so that cleaned surfaces blend smoothly into surrounding areas.
- E. Water Application Methods:
- 1. Water-Spray Applications: Unless otherwise indicated, hold spray nozzle at least 6 inches from masonry surface and apply water in horizontal back-and-forth sweeping motion, overlapping previous strokes to produce uniform coverage.
- F. Rinse off cleaning residue and soil by working upward from bottom to top of each treated area at each stage or scaffold setting.
- G. After cleaning is complete, remove protection no longer required. Remove tape and adhesive marks.

3.3 PRELIMINARY CLEANING

- A. Removing Plant Growth: Completely remove visible plant, moss, and shrub growth from masonry surfaces. Carefully remove plants, creepers, and vegetation by cutting at roots and allowing remaining growth to dry as long as possible before removal. Remove loose soil and plant debris from open joints to whatever depth they occur.

3.4 CLEANING MASONRY

- A. Hot-Water Wash: Use hot water applied by low-pressure spray.
- B. Detergent Cleaning:
- 1. Wet surface with hot water applied by low-pressure spray.
 - 2. Scrub surface with detergent solution using medium-soft brushes until soil is thoroughly dislodged and can be removed by rinsing. Use small brushes to remove soil from mortar joints and crevices. Dip brush in solution often to ensure that adequate fresh detergent is used and that surface remains wet.
 - 3. Rinse with hot water applied by low-pressure spray to remove detergent solution and soil.
- C. Mold, Mildew, and Algae Removal:
- 1. Wet surface with hot water applied by low-pressure spray.
 - 2. Apply mold, mildew, and algae remover by brush or low-pressure spray.

3. Scrub surface with medium-soft brushes until mold, mildew, and algae are thoroughly dislodged and can be removed by rinsing. Use small brushes for mortar joints and crevices. Dip brush in mold, mildew, and algae remover often to ensure that adequate fresh cleaner is used and that surface remains wet.
4. Rinse with hot water applied by low-pressure spray to remove mold, mildew, and algae remover and soil.

3.5 FINAL CLEANING

- A. Clean adjacent non-masonry surfaces of spillage and debris. Use detergent and soft brushes or cloths.
- B. Remove debris from gutters and downspouts. Rinse off roof and flush gutters and downspouts.
- C. Remove masking materials, leaving no residues that could trap dirt.

END OF SECTION 040110

SECTION 040120.64 - BRICK MASONRY REPOINTING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification Sections, apply to work of this section.

1.2 SUMMARY

- A. Work in this Section applies solely to the renovation and improvements to the Administration/Operations Building (building #1).
- B. Section Includes:
 - 1. Repointing joints with mortar.
- C. Related Requirements:
 - 1. Section 013516 "Alteration Project Procedures" for general remodeling, renovation, repair, and maintenance requirements.

1.3 SEQUENCING AND SCHEDULING

- A. Order sand and gray portland cement for pointing mortar immediately after approval of Samples. Take delivery of and store at Project site enough quantity to complete Project.
- B. Work Sequence: Perform brick masonry repointing work in the following sequence, which includes work specified in this and other Sections:
 - 1. Remove plant growth.
 - 2. Inspect masonry for open mortar joints and permanently or temporarily point them before cleaning to prevent the intrusion of water and other cleaning materials into the wall.
 - 3. Clean masonry.
 - 4. Rake out mortar from joints surrounding masonry to be replaced and from joints adjacent to masonry repairs along joints.
 - 5. Repair masonry, including replacing existing masonry with masonry materials salvaged from elsewhere on the project.
 - 6. Rake out mortar from joints to be repointed.
 - 7. Point mortar and sealant joints.
 - 8. After repairs and repointing have been completed and cured, perform a final cleaning to remove residues from this work.

1.4 ACTION SUBMITTALS

- A. Samples for Initial Selection: For the following:
 - 1. Pointing Mortar: Submit sets of mortar for pointing in the form of sample mortar

strips, 6 inches long by 1/2 inch wide, set in aluminum or plastic channels.

- a. Have each set contain a close color range of at least three Samples of different mixes of colored sands and cements that produce a mortar matching existing, cleaned mortar when cured and dry.
 - b. Submit with precise measurements on ingredients, proportions, gradations, and source of colored sands from which each Sample was made.
2. Sand Type Used for Pointing Mortar: Minimum 8 oz. of each in plastic screw-top jars.
 3. Include similar Samples of accessories involving color selection.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For brick masonry repointing specialist.
- B. Quality-control program.

1.6 QUALITY ASSURANCE

- A. Brick Masonry Repointing Specialist Qualifications: Engage an experienced brick masonry repointing firm to perform work of this Section. Firm shall have completed work similar in material, design, and extent to that indicated for this Project with a record of successful in-service performance. Experience in only installing masonry is insufficient experience for masonry repointing work.
 1. Field Supervision: Brick masonry repointing specialist firms shall maintain experienced full-time supervisors on Project site during times that brick masonry repointing work is in progress.
- B. Quality-Control Program: Prepare a written quality-control program for this Project to systematically demonstrate the ability of personnel to properly follow methods and use materials and tools without damaging masonry. Include provisions for supervising performance and preventing damage.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Deliver packaged materials to Project site in manufacturer's original and unopened containers, labeled with manufacturer's name and type of products.
- B. Store cementitious materials on elevated platforms, under cover, and in a dry location. Do not use cementitious materials that have become damp.
- C. Store hydrated lime in manufacturer's original and unopened containers. Discard lime if containers have been damaged or have been opened for more than two days.
- D. Store sand where grading and other required characteristics can be maintained and contamination avoided.

1.8 FIELD CONDITIONS

- A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit repointing work to be performed according to product manufacturers' written instructions and specified requirements.
- B. Temperature Limits: Repoint mortar joints only when air temperature is between 40 and 90 deg F and is predicted to remain so for at least seven days after completion of the Work unless otherwise indicated.
- C. Hot-Weather Requirements: Protect mortar-joint pointing when temperature and humidity conditions produce excessive evaporation of water from mortar materials. Provide artificial shade and wind breaks, and use cooled materials as required to minimize evaporation. Do not apply mortar to substrates with temperatures of 90 deg F and above unless otherwise indicated.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Source Limitations: Obtain each type of material for repointing brick masonry (cement, sand, etc.) from single source with resources to provide materials of consistent quality in appearance and physical properties.

2.2 MORTAR MATERIALS

- A. Portland Cement: ASTM C150/C150M, Type I or Type II, except Type III may be used for cold-weather construction; white or gray, or both where required for color matching of mortar.
 - 1. Provide cement containing not more than 0.60 percent total alkali when tested according to ASTM C114.
- B. Hydrated Lime: ASTM C207, Type S.
- C. Mortar Sand: ASTM C144.
 - 1. Match size, texture, and gradation of existing mortar sand as closely as possible. Blend several sands if necessary to achieve suitable match.
 - 2. Color: Natural sand or ground marble, granite, or other sound stone of color necessary to produce mortar color to match existing.
- D. Water: Potable.

2.3 MORTAR MIXES

- A. Measurement and Mixing: Measure cementitious materials and sand in a dry condition by volume or equivalent weight. Do not measure by shovel; use known measure. Mix materials in a clean, mechanical batch mixer.

1. **Mixing Pointing Mortar:** Thoroughly mix cementitious materials and sand together before adding any water. Then mix again, adding only enough water to produce a damp, unworkable mix that retains its form when pressed into a ball. Maintain mortar in this dampened condition for 15 to 30 minutes. Add remaining water in small portions until mortar reaches desired consistency. Use mortar within one hour of final mixing; do not retemper or use partially hardened material.
- B. **Colored Mortar:** Produce mortar of color required by using specified ingredients. Do not alter specified proportions without A/E's approval.
 1. **Mortar Pigments:** Where mortar pigments are indicated, do not add pigment exceeding 10 percent by weight of the cementitious or binder materials, except for carbon black which is limited to 2 percent, unless otherwise demonstrated by a satisfactory history of performance.
- C. Do not use admixtures in mortar unless otherwise indicated.
- D. **Mixes:** Mix mortar materials in the following proportions:
 1. **Pointing Mortar by Type:** ASTM C270, Proportion Specification, Type N unless otherwise indicated; with cementitious material limited to portland cement and lime, masonry cement or mortar cement. Add mortar pigments to produce mortar colors required.

PART 3 - EXECUTION

3.1 PROTECTION

- A. Prevent mortar from staining face of surrounding masonry and other surfaces.
 1. Cover sills, ledges, and other projecting items to protect them from mortar droppings.
 2. Keep wall area wet below pointing work to discourage mortar from adhering.
 3. Immediately remove mortar splatters in contact with exposed masonry and other surfaces.
- B. Remove downspouts and associated hardware adjacent to masonry and store during masonry repointing. Reinstall when repointing is complete.
 1. Provide temporary rain drainage during work to direct water away from building.

3.2 MASONRY REPOINTING, GENERAL

- A. **Appearance Standard:** Repointed surfaces are to have a uniform appearance as viewed from 20 feet away by A/E.

3.3 REPOINTING

- A. Rake out and repoint joints to the following extent:

1. Joints at locations of the following defects:
 - a. Holes and missing mortar.
 - b. Cracks that can be penetrated 1/4 inch or more by a knife blade 0.027 inch thick.
 - c. Cracks 1/16 inch or more in width and of any depth.
 - d. Hollow-sounding joints when tapped by metal object.
 - e. Eroded surfaces 1/4 inch or more deep.
 - f. Deterioration to point that mortar can be easily removed by hand, without tools.
 - g. Joints filled with substances other than mortar.
- B. Do not rake out and repoint joints where not required.
- C. Rake out joints as follows, according to procedures demonstrated in approved mockup:
 1. Remove mortar from joints to depth of 2 times joint width and not less than that required to expose sound, unweathered mortar. Do not remove unsound mortar more than 2 inches deep; consult A/E for direction.
 2. Remove mortar from brick and other masonry surfaces within raked-out joints to provide reveals with square backs and to expose masonry for contact with pointing mortar. Brush, vacuum, or flush joints to remove dirt and loose debris.
 3. Do not spall edges of brick or other masonry units or widen joints. Replace or patch damaged brick or other masonry units as directed by A/E.
- D. Notify A/E of unforeseen detrimental conditions including voids in mortar joints, cracks, loose masonry units, rotted wood, rusted metal, and other deteriorated items.
- E. Pointing with Mortar:
 1. Rinse joint surfaces with water to remove dust and mortar particles. Time rinsing application so, at time of pointing, joint surfaces are damp but free of standing water. If rinse water dries, dampen joint surfaces before pointing.
 2. Apply pointing mortar first to areas where existing mortar was removed to depths greater than surrounding areas. Apply in layers not greater than 3/8 inch until a uniform depth is formed. Fully compact each layer, and allow it to become thumbprint hard before applying next layer.
 3. After deep areas have been filled to same depth as remaining joints, point joints by placing mortar in layers not greater than 3/8 inch. Fully compact each layer and allow to become thumbprint hard before applying next layer. Where existing masonry units have worn or rounded edges, slightly recess finished mortar surface below face of masonry to avoid widened joint faces. Take care not to spread mortar beyond joint edges onto exposed masonry surfaces or to featheredge the mortar.
 4. When mortar is thumbprint hard, tool joints to match original appearance of joints as demonstrated in approved mockup. Remove excess mortar from edge of joint by brushing.
 5. Cure mortar by maintaining in thoroughly damp condition for at least 72 consecutive hours, including weekends and holidays.

- F. Where repointing work precedes cleaning of existing masonry, allow mortar to harden at least 30 days before beginning cleaning work.

3.4 FINAL CLEANING

- A. After mortar has fully hardened, thoroughly clean exposed masonry surfaces of excess mortar and foreign matter; use wood scrapers, stiff-nylon or -fiber brushes, and clean water applied by low-pressure spray.
 - 1. Do not use metal scrapers or brushes.
 - 2. Do not use acidic or alkaline cleaners.
- B. Clean adjacent non-masonry surfaces. Use detergent and soft brushes or cloths.
- C. Remove masking materials, leaving no residues that could trap dirt.

END OF SECTION 040120.64

SECTION 042200 - CONCRETE UNIT MASONRY

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification Sections, apply to work of this section.

1.2 SUMMARY

- A. Section Includes:

1. Concrete masonry units.
2. Mortar and grout materials.
3. Reinforcement.
4. Masonry-joint reinforcement.
5. Embedded flashing materials.
6. Miscellaneous masonry accessories.
7. Masonry-cell insulation.

- B. Products Installed, but Not Furnished, under This Section:

1. Cast-stone trim in accordance with Section 047200 "Cast Stone Masonry" in concrete unit masonry.

- C. Related Requirements:

1. Section 031000 "Concrete Forming and Accessories" for dovetail slots for masonry anchors.
2. Section 051200 "Structural Steel Framing" for installing anchor sections of adjustable masonry anchors for connecting to structural steel frame.
3. Section 071900 "Water Repellents" for water repellents applied to surface of unit masonry assemblies.
4. Section 076200 "Sheet Metal Flashing and Trim" for exposed sheet metal flashing and for furnishing manufactured reglets installed in masonry joints.

1.3 DEFINITIONS

- A. CMU(s): Concrete masonry unit(s).
- B. Reinforced Masonry: Masonry containing reinforcing steel in grouted cells.
- C. Exposed: Weather-exposed side of a constructed wall.

1.4 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.

1.5 ACTION SUBMITTALS

- A. Shop Drawings: For the following:
 - 1. Masonry Units: Show sizes, profiles, coursing, and locations of special shapes.
 - 2. Reinforcing Steel: Detail bending, lap lengths, and placement of unit masonry reinforcing bars. Comply with ACI 315.
 - 3. Lintel design and types required.
- B. Samples for Initial Selection:
 - 1. Architectural CMUs, in the form of small-scale units.
 - 2. Colored mortar.

1.6 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For testing agency.
- B. Material Certificates: For each type and size of the following:
 - 1. Masonry units.
 - a. Include material test reports substantiating compliance with requirements.
 - b. For masonry units used in structural masonry, include data and calculations establishing average net-area compressive strength of units.
 - 2. Integral water repellent used in CMUs, if not surface treated.
 - 3. Cementitious materials. Include name of manufacturer, brand name, and type.
 - 4. Mortar admixtures.
 - 5. Preblended, dry mortar mixes. Include description of type and proportions of ingredients.
 - 6. Grout mixes. Include description of type and proportions of ingredients.
 - 7. Reinforcing bars.
 - 8. Joint reinforcement.
 - 9. Anchors, ties, and metal accessories.
- C. Mix Designs: For each type of mortar and grout. Include description of type and proportions of ingredients.
 - 1. Include test reports for mortar mixes required to comply with property specification. Test in accordance with ASTM C109/C109M for compressive strength, ASTM C1506 for water retention, and ASTM C91/C91M for air content.
 - 2. Include test reports, in accordance with ASTM C1019, for grout mixes required to comply with compressive strength requirement.
- D. Statement of Compressive Strength of Masonry: For each combination of masonry unit type and mortar type, provide statement of average net-area compressive strength of masonry units, mortar type, and resulting net-area compressive strength of masonry determined in accordance with TMS 402/602.

- E. Weather Procedures:
 - 1. Cold-Weather Procedures: Detailed description of methods, materials, and equipment to be used to comply with requirements.
 - 2. Hot-Weather Procedures: Detailed description of methods, materials, and equipment to be used to comply with requirements.

1.7 QUALITY ASSURANCE

- A. Project team craftworkers of the Masonry Contractor assigned to Project will be required to have the International Masonry Institute - Flashing Training or equal and to provide evidence of certificate or a letter of the firm's commitment to enroll key project personnel in the training program prior to the start of Project.
- B. Project team craftworkers of the Masonry Contractor assigned to Project will be required to have the International Masonry Institute - Grouting and Reinforcing Training or equal and to provide evidence of certificate or a letter of the firm's commitment to enroll key project personnel in the training program prior to the start of Project.
- C. Sample Panels: Build sample panels to verify selections made under Sample submittals and to demonstrate aesthetic effects.
 - 1. Build sample panels for typical exterior wall in sizes approximately 48 inches long by 48 inches high by full thickness.
 - 2. Build sample panels facing south.
 - 3. Protect approved sample panels from the elements with weather-resistant membrane.
 - 4. Approval of sample panels is for color, texture, and blending of masonry units; relationship of mortar and sealant colors to masonry unit colors; tooling of joints; aesthetic qualities of workmanship; and other material and construction qualities specifically approved by A/E in writing.
 - a. Approval of sample panels does not constitute approval of deviations from the Contract Documents contained in sample panels unless A/E specifically approves such deviations in writing.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Store masonry units on elevated platforms in a dry location. If units are not stored in an enclosed location, cover tops and sides of stacks with waterproof sheeting, securely tied. If units become wet, do not install until they are dry.
- B. Store cementitious materials on elevated platforms, under cover, and in a dry location. Do not use cementitious materials that have become damp.
- C. Store aggregates where grading and other required characteristics can be maintained and contamination avoided.

- D. Deliver preblended, dry mortar mix in moisture-resistant containers. Store preblended, dry mortar mix in delivery containers on elevated platforms in a dry location or in covered weatherproof dispensing silos.
- E. Store masonry accessories, including metal items, to prevent corrosion and accumulation of dirt and oil.

1.9 FIELD CONDITIONS

- A. Protection of Masonry: During construction, cover tops of walls, projections, and sills with waterproof sheeting at end of each day's work. Cover partially completed masonry when construction is not in progress.
 - 1. Extend cover a minimum of 24 inches down both sides of walls, and hold cover securely in place.
- B. Do not apply uniform floor or roof loads for at least 12 hours and concentrated loads for at least three days after building masonry walls or columns.
- C. Stain Prevention: Prevent grout, mortar, and soil from staining the face of masonry to be left exposed or painted. Immediately remove grout, mortar, and soil that come in contact with such masonry.
 - 1. Protect base of walls from rain-splashed mud and from mortar splatter by spreading coverings on ground and over wall surface.
 - 2. Protect sills, ledges, and projections from mortar droppings.
 - 3. Protect surfaces of window and door frames, as well as similar products with painted and integral finishes, from mortar droppings.
 - 4. Turn scaffold boards near the wall on edge at the end of each day to prevent rain from splashing mortar and dirt onto completed masonry.
- D. Cold-Weather Requirements: Do not use frozen materials or materials mixed or coated with ice or frost. Do not build on frozen substrates. Remove and replace unit masonry damaged by frost or by freezing conditions. Comply with cold-weather construction requirements contained in TMS 402/602.
 - 1. Cold-Weather Cleaning: Use liquid cleaning methods only when air temperature is 40 deg F and higher and will remain so until masonry has dried, but not less than seven days after completing cleaning.
- E. Hot-Weather Requirements: Comply with hot-weather construction requirements contained in TMS 402/602.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

- A. Source Limitations for Masonry Units: Obtain exposed masonry units of a uniform

texture and color, or a uniform blend within the ranges accepted for these characteristics, from single source from single manufacturer for each product required.

- B. Source Limitations for Mortar Materials: Obtain mortar ingredients of a uniform quality, including color for exposed masonry, from single manufacturer for each cementitious component and from single source or producer for each aggregate.
- C. Source Limitations for Integral Water Repellent: Obtain integral water-repellent units from CMU and mortar manufacturer.

2.2 PERFORMANCE REQUIREMENTS

- A. Provide unit masonry that develops indicated net-area compressive strengths at 28 days.
 - 1. Determine net-area compressive strength of masonry from average net-area compressive strengths of masonry units and mortar types (unit-strength method) in accordance with Tables 1 and 2 in TMS 402/602.
- B. Regulatory Requirements: Comply with the provisions of the following codes, specifications, and standards, except as otherwise shown or specified:
 - 1. TMS 402/602:
 - a. Maintain one copy of the standard in Project field office at all times during construction. Contractor's supervisory personnel are to be thoroughly familiar with this material as it applies to Project.

2.3 CONCRETE UNIT MASONRY, GENERAL

- A. Masonry Standard: Comply with TMS 402/602 except as modified by requirements in the Contract Documents.
- B. Defective Units: Referenced masonry unit standards may allow a certain percentage of units to contain chips, cracks, or other defects exceeding limits stated. Do not use units where such defects are exposed in the completed Work and will be within 20 ft. vertically and horizontally of a walking surface.
- C. Shapes: Provide shapes indicated and as follows, with exposed surfaces matching exposed faces of adjacent units unless otherwise indicated.
 - 1. Provide special shapes for lintels, corners, jambs, sashes, movement joints, headers, bonding, and other special conditions.
 - 2. Provide square-edged units for outside corners unless otherwise indicated.
- D. Building Lintels:
 - 1. Masonry Lintels: Prefabricated or built-in-place masonry lintels made from bond beam CMUs matching adjacent CMUs in color, texture, and density classification, with reinforcing bars placed as indicated and filled with coarse grout.
 - a. Knockout blocks will not be acceptable.

2. Concrete Lintels: Complying with requirements in Section 033000 "Cast-in-Place Concrete," and with reinforcing bars indicated.
3. Manufactured Concrete Lintels, ASTM C1623: Provide lintels with net-area compressive strength not less than CMUs.

2.4 CONCRETE MASONRY UNITS

A. Architectural CMUs:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Cemex USA
 - b. Echelon
 - c. Midwest Block and Brick
2. Density Classification: Normal weight.
3. Size (Width): Manufactured to dimensions 3/8 inch less-than-nominal dimensions.
4. Pattern and Texture:
 - a. Scored vertically so units laid in running bond appear as square units laid in stacked bond, standard finish. Match existing buildings.
5. Colors: As selected by A/E from manufacturer's full range.

2.5 MORTAR AND GROUT MATERIALS

- A. Portland Cement: ASTM C150/C150M, Type I or II, except Type III may be used for cold-weather construction. Provide natural color or white cement as required to produce mortar color indicated.
 1. Alkali content is not more than 0.1 percent when tested in accordance with ASTM C114.
- B. Hydrated Lime: ASTM C207, Type S.
- C. Portland Cement-Lime Mix: Packaged blend of portland cement and hydrated lime containing no other ingredients.
- D. Mortar Pigments: Natural and synthetic iron oxides and chromium oxides, compounded for use in mortar mixes and complying with ASTM C979/C979M. Use only pigments with a record of satisfactory performance in masonry mortar.
 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Davis Colors
 - b. Euclid Chemical Company (The); a subsidiary of RPM International, Inc.
 - c. Lanxess Corporation
 - d. Solomon Colors Inc.

- E. Colored Cement Products: Packaged blend made from portland cement and hydrated lime or mortar cement and mortar pigments, all complying with specified requirements, and containing no other ingredients.
 - 1. Formulate blend as required to produce color indicated or, if not indicated, as selected from manufacturer's standard colors.
 - 2. Pigments does not exceed 10 percent of portland cement by weight.
 - 3. Pigments does not exceed 5 percent of mortar cement by weight.
- F. Aggregate for Mortar: ASTM C144.
 - 1. For mortar that is exposed to view, use washed aggregate consisting of natural sand or crushed stone.
 - 2. For joints less than 1/4 inch thick, use aggregate graded with 100 percent passing the No. 16 sieve.
 - 3. White-Mortar Aggregates: Natural white sand or crushed white stone.
 - 4. Colored-Mortar Aggregates: Natural sand or crushed stone of color necessary to produce required mortar color.
- G. Aggregate for Grout: ASTM C404.
- H. Epoxy Pointing Mortar: ASTM C395, epoxy-resin-based material formulated for use as pointing mortar for glazed or pre-faced masonry units (and approved for such use by manufacturer of units); in color indicated or, if not otherwise indicated, as selected by A/E from manufacturer's colors.
- I. Water: Potable.

2.6 REINFORCEMENT

- A. Uncoated-Steel Reinforcing Bars: ASTM A615/A615M or ASTM A996/A996M, Grade 60.
- B. Reinforcing Bar Positioners: Wire units designed to fit into mortar bed joints spanning masonry unit cells and to hold reinforcing bars in center of cells. Units are formed from 0.148-inch steel wire, hot-dip galvanized after fabrication. Provide units designed for number of bars indicated.
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Heckmann Building Products, Inc.
 - b. Hohmann & Barnard, Inc
 - c. Wire-Bond
- C. Masonry-Joint Reinforcement, General: Ladder type complying with ASTM A951/A951M.
 - 1. Exterior Walls: Stainless steel.
 - 2. Wire Size for Side Rods: 0.148-inch diameter.

3. Wire Size for Cross Rods: 0.148-inch diameter.
4. Spacing of Cross Rods: Not more than 16 inches o.c.
5. Provide in lengths of not less than 10 ft., with prefabricated corner and tee units.

2.7 TIES AND ANCHORS

- A. General: Ties and anchors extend at least 1-1/2 inches into masonry but with at least a 5/8-inch cover on outside face.
- B. Materials: Provide ties and anchors specified in this article that are made from materials that comply with the following unless otherwise indicated:
 1. Stainless Steel Wire: ASTM A580/A580M, Type 304.
 2. Steel Sheet, Galvanized after Fabrication: ASTM A1008/A1008M commercial steel, with ASTM A153/A153M, Class B coating.
 3. Stainless Steel Sheet: ASTM A240/A240M or ASTM A666, Type 304.
 4. Steel Plates, Shapes, and Bars: ASTM A36/A36M.
- C. Adjustable Anchors for Connecting to Structural Steel Framing: Provide anchors that allow vertical or horizontal adjustment but resist tension and compression forces perpendicular to plane of wall.
 1. Anchor Section for Welding to Steel Frame: Crimped 1/4-inch-diameter, stainless steel wire.
 2. Tie Section: Triangular-shaped wire tie made from 0.187-inch-diameter, stainless steel wire.
- D. Adjustable Anchors for Connecting to Concrete: Provide anchors that allow vertical or horizontal adjustment but resist tension and compression forces perpendicular to plane of wall.
 1. Connector Section: Dovetail tabs for inserting into dovetail slots in concrete and attached to tie section; formed from 0.062-inch-thick, stainless steel sheet.
 2. Tie Section: Triangular-shaped wire tie made from 0.187-inch-diameter, stainless steel wire.
 3. Corrugated-Metal Ties: Metal strips not less than 7/8 inch wide with corrugations having a wavelength of 0.3 to 0.5 inch and an amplitude of 0.06 to 0.10 inch made from 0.062-inch-thick, stainless steel sheet with dovetail tabs for inserting into dovetail slots in concrete.

2.8 EMBEDDED FLASHING MATERIALS

- A. Embedded Flashing Applications: Unless otherwise indicated, use the following:
 1. Where flashing is indicated to receive counterflashing, use metal flashing.
 2. Where flashing is indicated to be turned down at or beyond the wall face, use metal flashing.
 3. Where flashing is partly exposed and is indicated to terminate at the wall face, use metal flashing with a drip edge or flexible flashing with a metal drip edge.

4. Where flashing is fully concealed, use metal flashing or flexible flashing.

B. Metal Flashing: Provide metal flashing complying with SMACNA's "Architectural Sheet Metal Manual" and as follows:

1. Stainless Steel: ASTM A240/A240M or ASTM A666, Type 304, 0.016 inch thick.
2. Fabricate continuous flashings in sections 96 inches long minimum, but not exceeding 12 ft.. Provide splice plates at joints of formed, smooth metal flashing.
3. Fabricate through-wall metal flashing embedded in masonry from stainless steel, with ribs at 3-inch intervals along length of flashing to provide an integral mortar bond.
4. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Cheney Flashing Company
 - b. Hohmann & Barnard, Inc
 - c. Keystone Flashing Company, Inc
5. Fabricate through-wall flashing with snaplock receiver on exterior face where indicated to receive counterflashing.
6. Fabricate through-wall flashing with drip edge unless otherwise indicated. Fabricate by extending flashing 1/2 inch out from wall, with outer edge bent down 30 degrees and hemmed.
7. Fabricate through-wall flashing with sealant stop unless otherwise indicated. Fabricate by bending metal back on itself 3/4 inch at exterior face of wall and down into joint 1/4 inch to form a stop for retaining sealant backer rod.
8. Fabricate metal drip edges, and, sealant stops for ribbed metal flashing from plain metal flashing of same metal as ribbed flashing and extending at least 3 inches into wall with hemmed inner edge to receive ribbed flashing and form a hooked seam. Form hem on upper surface of metal so that completed seam sheds water.

C. Flexible Flashing: Use one of the following unless otherwise indicated:

1. Self-Adhering, Stainless Steel Fabric Flashing: Composite, flashing product consisting of 2 mil of Type 316 stainless steel sheet, bonded to a layer of polymeric fabric with a butyl adhesive, to produce an overall thickness of 40 mil.
 - a. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1) Hohmann & Barnard, Inc
 - 2) STS Coatings, Inc.
 - 3) VaproShield LLC
 - 4) Wire-Bond
 - 5) York Manufacturing, Inc

- b. Applications: Use 10-mil- thick flashing at windows, doors, and small wall penetrations; not at base of walls. Use 40-mil- thick flashing at base of walls.
- 2. Butyl Rubber Flashing: Composite, self-adhesive, flashing product consisting of a pliable, butyl rubber compound, bonded to a high-density polyethylene film, aluminum foil, or spunbonded polyolefin to produce an overall thickness of not less than 35 mil.
 - a. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1) DuPont de Nemours, Inc.
 - 2) GCP Applied Technologies Inc.
 - 3) Protecto Wrap Company
 - 4) Viaflex
 - 5) Wire-Bond
 - b. Accessories: Provide preformed corners, end dams, other special shapes, and seaming materials produced by flashing manufacturer.
- 3. Elastomeric Thermoplastic Flashing: Composite flashing product consisting of a polyester-reinforced ethylene interpolymer alloy.
 - a. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1) Hohmann & Barnard, Inc
 - 2) Hyload; IKO Industries, Inc.
 - 3) Mortar Net Solutions
 - 4) Wire-Bond
 - b. Monolithic Sheet: Elastomeric thermoplastic flashing, 40 mil thick.
 - c. Self-Adhesive Sheet: Elastomeric thermoplastic flashing, 25 mil thick, with a 15-mil- thick coating of adhesive.
 - 1) Color: Black.
 - d. Accessories: Provide preformed corners, end dams, other special shapes, and seaming materials produced by flashing manufacturer.
- 4. EPDM Flashing: Sheet flashing product made from ethylene-propylene-diene terpolymer, complying with ASTM D4637/D4637M, 40 mil thick.
 - a. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

- 1) Carlisle Coatings & Waterproofing Inc
- 2) Elevate; Holcim Building Envelope
- 3) Heckmann Building Products, Inc.
- 4) Hohmann & Barnard, Inc
- 5) Wire-Bond

- D. Solder and Sealants for Sheet Metal Flashings: As specified in Section 076200 "Sheet Metal Flashing and Trim."
1. Solder for Stainless Steel: ASTM B32, Grade Sn60, with acid flux of type recommended by stainless steel sheet manufacturer.
 2. Elastomeric Sealant: ASTM C920, chemically curing urethane sealant; of type, grade, class, and use classifications required to seal joints in sheet metal flashing and remain watertight.
- E. Adhesives, Primers, and Seam Tapes for Flashings: Flashing manufacturer's standard products or products recommended by flashing manufacturer for bonding flashing sheets to each other and to substrates.

2.9 MISCELLANEOUS MASONRY ACCESSORIES

- A. Compressible Filler: Premolded filler strips complying with ASTM D1056, Grade 2A1; compressible up to 35 percent; of width and thickness indicated; formulated from neoprene.
- B. Preformed Control-Joint Gaskets: Made from styrene-butadiene-rubber compound, complying with ASTM D2000, Designation M2AA-805 or PVC, complying with ASTM D2287, Type PVC-65406 and designed to fit standard sash block and to maintain lateral stability in masonry wall; size and configuration as indicated.
- C. Bond-Breaker Strips: Asphalt-saturated felt complying with ASTM D226/D226M, Type I (No. 15 asphalt felt).

2.10 MASONRY-CELL INSULATION

- A. Molded-Polystyrene Insulation Units: CMU units with molded rigid expandable polystyrene-inserts to comply with ASTM C578, Type 1. Provide insulated block units designed for installing in cores of masonry units.

2.11 MORTAR AND GROUT MIXES

- A. General: Do not use admixtures, including pigments, air-entraining agents, accelerators, retarders, water-repellent agents, antifreeze compounds, or other admixtures unless otherwise indicated.

1. Do not use calcium chloride in mortar or grout.
 2. Use portland cement-lime, or, mortar cement mortar unless otherwise indicated.
 3. Add cold-weather admixture (if used) at same rate for all mortar that will be exposed to view, regardless of weather conditions, to ensure that mortar color is consistent.
- B. Preblended, Dry Mortar Mix: Furnish dry mortar ingredients in form of a preblended mix. Measure quantities by weight to ensure accurate proportions, and thoroughly blend ingredients before delivering to Project site.
- C. Mortar for Unit Masonry: Comply with ASTM C270, Proportion Specification. Provide the following types of mortar for applications stated unless another type is indicated or needed to provide required compressive strength of masonry.
1. For masonry below grade or in contact with earth, use Type M.
 2. For reinforced masonry, use Type S.
 3. For exterior, above-grade, load-bearing and non-load-bearing walls and parapet walls; for interior load-bearing walls; for interior non-load-bearing partitions; and for other applications where another type is not indicated, use Type N.
- D. Pigmented Mortar: Use colored cement product or select and proportion pigments with other ingredients to produce color required. Do not add pigments to colored cement products.
1. Pigments does not exceed 10 percent of portland cement by weight.
 2. Pigments does not exceed 5 percent of mortar cement by weight.
 3. Mix to match A/E's sample.
 4. Application: Use pigmented mortar for exposed mortar joints with the following units:
 - a. Architectural CMUs.
- E. Colored-Aggregate Mortar: Produce required mortar color by using colored aggregates and natural color or white cement as necessary to produce required mortar color.
1. Mix to match A/E's sample.
 2. Application: Use colored-aggregate mortar for exposed mortar joints with the following units:
 - a. Architectural CMUs.
- F. Grout for Unit Masonry: Comply with ASTM C476.
1. Use grout of type indicated or, if not otherwise indicated, of type (fine or coarse) that will comply with TMS 402/602 for dimensions of grout spaces and pour height.
 2. Proportion grout in accordance with ASTM C476, Table 1, or.
 3. Provide grout with a slump of 8 to 11 inches as measured in accordance with ASTM C143/C143M.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
 - 1. For the record, prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.
 - 2. Verify that foundations are within tolerances specified.
 - 3. Verify that reinforcing dowels are properly placed.
 - 4. Verify that substrates are free of substances that would impair mortar bond.
- B. Before installation, examine rough-in and built-in construction for piping systems to verify actual locations of piping.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION, GENERAL

- A. Build chases and recesses to accommodate items specified in this and other Sections.
- B. Leave openings for equipment to be installed before completing masonry. After installing equipment, complete masonry to match construction immediately adjacent to opening.
- C. Use full-size units without cutting if possible. If cutting is required to provide a continuous pattern or to fit adjoining construction, cut units with motor-driven saws; provide clean, sharp, unchipped edges. Allow units to dry before laying unless wetting of units is specified. Install cut units with cut surfaces and, where possible, cut edges concealed.
- D. Exposed Masonry: Mix units to product uniform blend of colors and textures.
- E. Temperature Control: Perform temperature-sensitive construction procedures while masonry Work is progressing. Temperature ranges indicated below apply to air temperatures existing at time of installation except for grout. For grout, temperature ranges apply to anticipated minimum night temperatures. In heating mortar and grout materials, maintain mixing temperature selected within 10 deg F.
 - 1. 40 to 32 Deg F (4 to 0 Deg C):
 - a. Mortar: Heat mixing water to produce mortar temperature between 40 and 120 deg F.
 - b. Grout: Follow normal masonry procedures.
 - 2. 32 to 25 Deg F (0 to Minus 4 Deg C):
 - a. Mortar: Heat mixing water and sand to produce mortar temperatures between 40 and 120 deg F; maintain temperature of mortar on boards above freezing.

- b. Grout: Heat grout materials to 90 deg F to produce in-place grout temperature of 70 deg F at end of workday.
 - 3. 25 to 20 Deg F (Minus 4 to 7 Deg C):
 - a. Mortar: Heat mixing water and sand to produce mortar temperatures between 40 and 120 deg F; maintain temperature of mortar on boards above freezing.
 - b. Grout: Heat grout materials to 90 deg F to produce in-place grout temperature of 70 deg F at end of workday.
 - c. Heat both sides of walls under construction using salamanders or other heat sources.
 - d. Use windbreaks or enclosures when wind is in excess of 15 mph.
 - 4. 20 Deg F (Minus 7 Deg C) and Below:
 - a. Mortar: Heat mixing water and sand to produce mortar temperatures between 40 and 120 deg F.
 - b. Grout: Heat grout materials to 90 deg F to produce in-place grout temperature of 70 deg F at end of workday.
 - c. Masonry Units: Heat masonry units so that they are above 20 deg F at time of laying.
 - d. Provide enclosure and auxiliary heat to maintain an air temperature of at least 40 deg F for 24 hours after laying units.
 - 5. Do not heat water for mortar and grout to above 160 deg F.
- F. Masonry Protection: Protect completed masonry and masonry not being worked on in the following manner. Temperature ranges indicated apply to mean daily air temperatures except for grouted masonry. For grouted masonry, temperature ranges apply to anticipated minimum night temperatures.
 - 1. 40 to 32 Deg F (4 to 0 Deg C): Protect masonry from rain or snow for at least 24 hours by covering with weather-resistive membrane.
 - 2. 32 to 25 Deg F (0 to Minus 4 Deg C): Completely cover masonry with weather-resistive membrane for at least 24 hours.
 - 3. 25 to 20 Deg F (Minus 4 to 7 Deg C): Completely cover masonry with weather-resistive insulating blankets or similar protection for at least 24 hours, 48 hours for grouted masonry.
 - 4. 20 Deg F (Minus 7 Deg C) and Below: Except as otherwise indicated, maintain masonry temperature above 32 deg F (0 deg C) for 24 hours using enclosures and supplementary heat, electric heating blankets, infrared lamps or other methods proven to be satisfactory. For grouted masonry, maintain heated enclosure to 40 deg F for 48 hours.

3.3 TOLERANCES

A. Dimensions and Locations of Elements:

- 1. For dimensions in cross section or elevation, do not vary by more than plus 1/2 inch or minus 1/4 inch.

2. For location of elements in plan, do not vary from that indicated by more than plus or minus 1/2 inch.
3. For location of elements in elevation, do not vary from that indicated by more than plus or minus 1/4 inch in a story height or 1/2 inch total.

B. Lines and Levels:

1. For bed joints and top surfaces of bearing walls, do not vary from level by more than 1/4 inch in 10 ft., or 1/2 inch maximum.
2. For conspicuous horizontal lines, such as lintels, sills, parapets, and reveals, do not vary from level by more than 1/8 inch in 10 ft., 1/4 inch in 20 ft., or 1/2 inch maximum.
3. For vertical lines and surfaces, do not vary from plumb by more than 1/4 inch in 10 ft., 3/8 inch in 20 ft., or 1/2 inch maximum.
4. For conspicuous vertical lines, such as external corners, door jambs, reveals, and expansion and control joints, do not vary from plumb by more than 1/8 inch in 10 ft., 1/4 inch in 20 ft., or 1/2 inch maximum.
5. For lines and surfaces, do not vary from straight by more than 1/4 inch in 10 ft., 3/8 inch in 20 ft., or 1/2 inch maximum.
6. For vertical alignment of exposed head joints, do not vary from plumb by more than 1/4 inch in 10 ft. or 1/2 inch maximum.
7. For faces of adjacent exposed masonry units, do not vary from flush alignment by more than 1/16 inch.

C. Joints:

1. For bed joints, do not vary from thickness indicated by more than plus or minus 1/8 inch, with a maximum thickness limited to 1/2 inch.
2. For exposed bed joints, do not vary from bed-joint thickness of adjacent courses by more than 1/8 inch.
3. For head and collar joints, do not vary from thickness indicated by more than plus 3/8 inch or minus 1/4 inch.
4. For exposed head joints, do not vary from thickness indicated by more than plus or minus 1/8 inch.

3.4 LAYING MASONRY WALLS

- A. Lay out walls in advance for accurate spacing of surface bond patterns with uniform joint thicknesses and for accurate location of openings, movement-type joints, returns, and offsets. Avoid using less-than-half-size units, particularly at corners, jambs, and, where possible, at other locations.
- B. Bond Pattern for Exposed Masonry: Unless otherwise indicated, lay exposed masonry in running bond; do not use units with less-than-nominal 4-inch horizontal face dimensions at corners or jambs.

- C. Stopping and Resuming Work: Stop work by stepping back units in each course from those in course below; do not tooth. When resuming work, clean masonry surfaces that are to receive mortar, remove loose masonry units and mortar, and wet brick if required before laying fresh masonry.
- D. Built-in Work: As construction progresses, build in items specified in this and other Sections. Fill in solidly with masonry around built-in items.
- E. Fill space between steel frames and masonry solidly with mortar unless otherwise indicated.
- F. Where built-in items are to be embedded in cores of hollow masonry units, place a layer of metal lath, wire mesh, or plastic mesh in the joint below, and rod mortar or grout into core.
- G. Fill cores in hollow CMUs with grout 24 inches under bearing plates, beams, lintels, posts, and similar items unless otherwise indicated.

3.5 MORTAR BEDDING AND JOINTING

- A. Lay hollow CMUs as follows:
 - 1. Bed face shells in mortar and make head joints of depth equal to bed joints.
 - 2. Bed webs in mortar in all courses of piers, columns, and pilasters.
 - 3. Bed webs in mortar in grouted masonry, including starting course on footings.
 - 4. Fully bed entire units, including areas under cells, at starting course on footings where cells are not grouted.
- B. Lay solid CMUs with completely filled bed and head joints; butter ends with sufficient mortar to fill head joints and shove into place. Do not deeply furrow bed joints or slush head joints.
- C. Where applicable, set masonry trim units in full bed of mortar with full vertical joints. Fill dowel, anchor, and similar holes.
 - 1. Clean soiled surfaces with fiber brush and soap powder and rinse thoroughly with clear water.
 - 2. Wet joint surfaces thoroughly before applying mortar.
 - 3. Rake out mortar joints for pointing with sealant.
- D. Rake out mortar joints at pre-faced CMUs to a uniform depth of 1/4 inch and point with epoxy mortar to comply with epoxy-mortar manufacturer's written instructions.
- E. Tool exposed joints slightly concave when thumbprint hard, using a jointer larger than joint thickness unless otherwise indicated.

F. Cut joints flush for masonry walls to receive plaster or other direct-applied finishes (other than paint) unless otherwise indicated.

G. Cut joints flush where indicated to receive waterproofing unless otherwise indicated.

3.6 MASONRY-CELL FILL INSTALLATION

A. Install molded-polystyrene insulation units into masonry unit cells before laying units.

3.7 MASONRY-JOINT REINFORCEMENT

A. General: Install entire length of longitudinal side rods in mortar with a minimum cover of 5/8 inch on exterior side of walls, 1/2 inch elsewhere. Lap reinforcement a minimum of 6 inches.

1. Space reinforcement not more than 16 inches o.c.
2. Space reinforcement not more than 8 inches o.c. in foundation walls and parapet walls.
3. Provide reinforcement not more than 8 inches above and below wall openings and extending 12 inches beyond openings in addition to continuous reinforcement.

B. Interrupt joint reinforcement at control and expansion joints unless otherwise indicated.

C. Provide continuity at wall intersections by using prefabricated T-shaped units.

D. Provide continuity at corners by using prefabricated L-shaped units.

E. Cut and bend reinforcing units as directed by manufacturer for continuity at returns, offsets, column fireproofing, pipe enclosures, and other special conditions.

3.8 ANCHORING MASONRY TO STRUCTURAL STEEL AND CONCRETE

A. Anchor masonry to structural steel and concrete, where masonry abuts or faces structural steel or concrete, to comply with the following:

1. Provide an open space not less than 1 inch wide between masonry and structural steel or concrete unless otherwise indicated. Keep open space free of mortar and other rigid materials.
2. Anchor masonry with anchors embedded in masonry joints and attached to structure.
3. Space anchors as indicated, but not more than 24 inches o.c. vertically and 36 inches o.c. horizontally.

3.9 CONTROL JOINTS

A. General: Install control joint materials in CMUs as masonry progresses. Do not allow materials to span control joints without provision to allow for in-plane wall or partition movement.

- B. Locate control joints. See Drawings.
- C. Form control joints in CMUs as follows:
 - 1. Fit bond-breaker strips into hollow contour in ends of CMUs on one side of control joint. Fill resultant core with grout and rake out joints in exposed faces for application of sealant.
 - 2. Install preformed control joint gaskets designed to fit standard sash block.
 - 3. Install interlocking units designed for control joints. Install bond-breaker strips at joint. Keep head joints free and clear of mortar or rake out joint for application of sealant.
 - 4. Install temporary foam-plastic filler in head joints and remove filler when unit masonry is complete for application of sealant.

3.10 LINTELS

- A. Install lintels over openings as indicated.
- B. Provide concrete or formed-in-place masonry lintels where shown and where openings of more than 12 inches for brick-size units and 24 inches for block-size units are shown without structural steel or other supporting lintels. Provide minimum bearing of 8 inches at each jamb unless otherwise indicated.

3.11 FLASHING

- A. General: Install embedded flashing at ledges and other obstructions to downward flow of water in wall where indicated.
- B. Install flashing as follows unless otherwise indicated:
 - 1. Prepare masonry surfaces so they are smooth and free from projections that could puncture flashing. Where flashing is within mortar joint, place through-wall flashing on sloping bed of mortar and cover with mortar. Before covering with mortar, seal penetrations in flashing with adhesive, sealant, or tape as recommended by flashing manufacturer.
 - 2. At lintels, extend flashing a minimum of 6 inches into masonry at each end. At heads and sills, extend flashing 6 inches at ends and turn up not less than 2 inches to form end dams.
 - 3. Interlock end joints of ribbed sheet metal flashing by overlapping ribs not less than 1-1/2 inches or as recommended by flashing manufacturer, and seal lap with elastomeric sealant complying with requirements in Section 079200 "Joint Sealants" for application indicated.
 - 4. Install metal drip edges, and, sealant stops with ribbed sheet metal flashing by interlocking hemmed edges to form hooked seam. Seal seam with elastomeric sealant complying with requirements in Section 079200 "Joint Sealants" for application indicated.

5. Install metal drip edges beneath flexible flashing at exterior face of wall. Stop flexible flashing 1/2 inch back from outside face of wall, and adhere flexible flashing to top of metal drip edge.
- C. Install single-wythe CMU flashing system in bed joints of CMU walls where indicated to comply with manufacturer's written instructions. Install CMU cell pans with upturned edges located below face shells and webs of CMUs above and with weep spouts aligned with face of wall. Install CMU web covers so that they cover upturned edges of CMU cell pans at CMU webs and extend from face shell to face shell.
- D. Install reglets and nailers for flashing and other related construction where they are shown to be built into masonry.

3.12 REINFORCED UNIT MASONRY

- A. Placing Reinforcement: Comply with requirements in TMS 402/602.
- B. Grouting: Do not place grout until entire height of masonry to be grouted has attained enough strength to resist grout pressure.
 1. Comply with requirements in TMS 402/602 for cleanouts and for grout placement, including minimum grout space and maximum pour height.
 2. Limit height of vertical grout pours to not more than 60 inches.

3.13 FIELD QUALITY CONTROL

- A. Testing and Inspecting: Owner will engage special inspectors to perform tests and inspections and prepare reports. Allow inspectors access to scaffolding and work areas as needed to perform tests and inspections. Retesting of materials that fail to comply with specified requirements is done at Contractor's expense.
- B. Inspections: Level 1 special inspections to comply with the International Building Code.
 1. Begin masonry construction only after inspectors have verified proportions of site-prepared mortar.
 2. Place grout only after inspectors have verified compliance of grout spaces, grades, sizes, and locations of reinforcement.
 3. Place grout only after inspectors have verified proportions of site-prepared grout.
- C. Testing Frequency: One set of tests for each 5000 sq. ft. of wall area or portion thereof.
- D. Concrete Masonry Unit Test: For each type of unit provided, in accordance with ASTM C140 for compressive strength.
- E. Mortar Aggregate Ratio Test (Proportion Specification): For each mix provided, in accordance with ASTM C780.

3.14 MASONRY WASTE DISPOSAL

- A. Salvageable Materials: Unless otherwise indicated, excess masonry materials are Contractor's property. At completion of unit masonry work, remove from Project site.
- B. Masonry Waste Recycling: Return broken CMUs not used as fill to manufacturer for recycling.
- C. Excess Masonry Waste: Remove excess clean masonry waste that cannot be recycled, and other masonry waste, and legally dispose of off Owner's property.

END OF SECTION 042200

SECTION 047200 - CAST STONE MASONRY

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification Sections, apply to work of this section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Decorative elements.
 - 2. Mortar materials.
 - 3. Accessories.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. For cast stone units, include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
- B. Shop Drawings: Show fabrication and installation details for cast stone units. Include dimensions, details of reinforcement and anchorages if any, and indication of finished faces.
 - 1. Include building elevations showing layout of units and locations of joints and anchors.

1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For manufacturer.

1.5 QUALITY ASSURANCE

- A. Manufacturer Qualifications: A qualified manufacturer of cast stone units similar to those indicated for this Project, that has sufficient production capacity to manufacture required units, and is a plant certified by CSI, or, APA, or, PCI for Group A, Category AT.
- B. Furnish cast stone for installation in mockups specified in Section 042000 "Unit Masonry."

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Coordinate delivery of cast stone with unit masonry work to avoid delaying the Work and to minimize the need for on-site storage.

- B. Pack, handle, and ship cast stone units in suitable packs or pallets.
 - 1. Lift with wide-belt slings; do not use wire rope or ropes that might cause staining. Move cast stone units if required, using dollies with wood supports.
 - 2. Store cast stone units on wood skids or pallets with nonstaining, waterproof covers, securely tied. Arrange to distribute weight evenly and to prevent damage to units. Ventilate under covers to prevent condensation.
- C. Store cementitious materials on elevated platforms, under cover, and in a dry location. Do not use cementitious materials that have become damp.
- D. Store mortar aggregates where grading and other required characteristics can be maintained, and contamination can be avoided.

1.7 PROJECT CONDITIONS

- A. Cold-Weather Requirements: Do not use frozen materials or materials mixed or coated with ice or frost. Do not build on frozen substrates. Comply with cold-weather construction requirements in TMS 602.
 - 1. Cold-Weather Cleaning: Use liquid cleaning methods only when air temperature is 40 deg F and above and will remain so until cast stone has dried, but no fewer than seven days after completing cleaning.
- B. Hot-Weather Requirements: Comply with hot-weather construction requirements in TMS 602.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

- A. Source Limitations for Cast Stone: Obtain cast stone units from single source from single manufacturer.
- B. Source Limitations for Mortar Materials: Obtain mortar ingredients of a uniform quality, including color, from one manufacturer for each cementitious component and from one source or producer for each aggregate.

2.2 CAST STONE MATERIALS

- A. General: Comply with ASTM C1364.
- B. Color Pigment: ASTM C979/C979M, synthetic mineral-oxide pigments or colored water-reducing admixtures; color stable, nonfading, and resistant to lime and other alkalis.
- C. Admixtures: Use only admixtures specified or approved in writing by A/E.
 - 1. Do not use admixtures that contain more than 0.1 percent water-soluble chloride ions by mass of cementitious materials. Do not use admixtures containing calcium

- chloride.
 - 2. Use only admixtures that are certified by manufacturer to be compatible with cement and other admixtures used.
- D. Embedded Anchors and Other Inserts: Fabricated from stainless steel complying with ASTM A240/A240M, ASTM A276/A276M, or ASTM A666, Type 304.

2.3 CAST STONE UNITS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
- 1. Indiana Cast Stone
 - 2. RockCast by Reading Rock, Inc.
- B. Cast Stone Units: Comply with ASTM C1364.
- 1. Units are manufactured using the manufacturer's selected method.
 - 2. Trim units including window sills, water tables.
- C. Fabricate units with sharp arris and accurately reproduced details, with indicated texture on all exposed surfaces unless otherwise indicated.
- 1. Slope exposed horizontal surfaces 1:12 to drain unless otherwise indicated.
 - 2. Provide raised fillets at backs of sills and at ends indicated to be built into jambs.
 - 3. Provide drips on projecting elements unless otherwise indicated.
- D. Fabrication Tolerances:
- 1. Variation in Cross Section: Do not vary from indicated dimensions by more than 1/8 inch.
 - 2. Variation in Length: Do not vary from indicated dimensions by more than 1/360 of the length of unit or 1/8 inch, whichever is greater, but in no case by more than 1/4 inch.
 - 3. Warp, Bow, and Twist: Not to exceed 1/360 of the length of unit or 1/8 inch, whichever is greater.
 - 4. Location of Grooves, False Joints, Holes, Anchorages, and Similar Features: Do not vary from indicated position by more than 1/8 inch on formed surfaces of units and 3/8 inch on unformed surfaces.
- E. Cure Units as Follows:
- 1. Cure units in enclosed, moist curing room at 95 percent relative humidity and temperature of 100 deg F for 12 hours or 70 deg F for 16 hours.
 - 2. Keep units damp and continue curing to comply with one of the following:
 - a. No fewer than five days at mean daily temperature of 70 deg F or above.
 - b. No fewer than seven days at mean daily temperature of 50 deg F or above.
- F. Acid etch units after curing to remove cement film from surfaces to be exposed to view.

- G. Colors and Textures: As selected by A/E from manufacturer's full range.

2.4 ACCESSORIES

- A. Anchors: Type and size indicated, fabricated from Type 304 stainless steel complying with ASTM A240/A240M, ASTM A276/A276M, or ASTM A666.
- B. Dowels: 1/2-inch- diameter round bars, fabricated from steel complying with ASTM A36/A36M and hot-dip galvanized to comply with ASTM A123/A123M.

2.5 MORTAR MIXES

- A. Comply with requirements in Section 042000 "Unit Masonry" for mortar mixes.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 SETTING CAST STONE IN MORTAR

- A. Set cast stone as indicated in TMS 604.
- B. Set cast stone as indicated on Drawings. Set units accurately in locations indicated, with edges and faces aligned according to established relationships and indicated tolerances.
 - 1. Install anchors, supports, fasteners, and other attachments indicated or necessary to secure units in place.
 - 2. Coordinate installation of cast stone with installation of flashing specified in other Sections.
- C. Wet joint surfaces thoroughly before applying mortar or setting in mortar.
- D. Set units in full bed of mortar with full head joints unless otherwise indicated.
 - 1. Set units with joints 1/4 to 3/8 inch wide unless otherwise indicated.
 - 2. Build anchors and ties into mortar joints as units are set.
 - 3. Fill dowel holes and anchor slots with mortar.
 - 4. Fill collar joints solid as units are set.
 - 5. Build concealed flashing into mortar joints as units are set.
 - 6. Keep head joints in copings and between other units with exposed horizontal surfaces open to receive sealant.

7. Keep joints at shelf angles open to receive sealant.
- E. Rake out joints for pointing with mortar to depths of not less than 3/4 inch. Rake joints to uniform depths with square bottoms and clean sides. Scrub faces of units to remove excess mortar as joints are raked.
- F. Point mortar joints by placing and compacting mortar in layers not greater than 3/8 inch. Compact each layer thoroughly and allow it to become thumbprint hard before applying next layer.
- G. Tool exposed joints slightly concave when thumbprint hard. Use a smooth plastic jointer larger than joint thickness.

3.3 ADJUSTING AND CLEANING

- A. Remove and replace stained and otherwise damaged units and units not matching approved Samples. Cast stone may be repaired if methods and results are approved by A/E.
- B. Replace units in a manner that results in cast stone matching approved Samples, complying with other requirements, and showing no evidence of replacement.
- C. Final Cleaning: After mortar is thoroughly set and cured, clean exposed cast stone as follows:
 1. Remove large mortar particles by hand with wooden paddles and nonmetallic scrape hoes or chisels.
 2. Wet surfaces with water before applying cleaners; remove cleaners promptly by rinsing thoroughly with clear water.
 3. Clean cast stone by methods described in Cast Stone Institute Technical Bulletin #39.

END OF SECTION 047200

SECTION 051200 - STRUCTURAL STEEL FRAMING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification Sections, apply to work of this section.

1.2 DESCRIPTION

- A. Work Included: All labor and materials required to furnish and install the structural steel work shown on the Drawings and required by these Specifications, including that shown on Mechanical or Electrical Drawings, or required in their Specification Sections.
- B. Related Work Specified Elsewhere: The general provisions of the Contract apply to the work of this Section, as though reproduced herein. Carefully examine all other Sections and all Drawings for related work.
- C. Work Furnished but Installed Under Other Sections: Anchor rods, loose bearing and base plates, and loose lintels.
- D. Work Affected by Others: Framing, bracing, loads, openings, and structure in any way related to Plumbing, HVAC, or Electrical requirements (if shown) is for bidding purposes only. Responsibility for coordinating the work of this Section with these requirements is solely that of the Contractor. Contractor's review of shop drawings will be taken to indicate that this coordination has been accomplished.
- E. Inspection and testing required by this Section is to be at the Owner's expense.

1.3 QUALITY ASSURANCE

- A. All structural steel construction shall comply with the governing codes including the latest adopted editions of the standards and material specifications referenced herein.
- B. Reference Standards:
 - 1. By the American Institute of Steel Construction (AISC):
 - a. ANSI/AISC 360, Specification for Structural Steel Buildings.
 - b. AISC 303, Code of Standard Practice for Steel Buildings and Bridges.
 - c. AISC 341, Seismic Provisions for Structural Steel Buildings, including supplements.
 - d. Specification of the Design of Steel Hollow Structural Sections.
 - 2. By the Research Council on Structural Connections (RCSC).
 - a. Specification for Structural Joints using High-Strength Bolts.
 - 3. By the American Welding Society (AWS):
 - a. Structural Welding Code - Steel ANSI/AWS D1.1.

- b. Standard Symbols for Welding, Brazing and Non-Destructive Examination, ANSI/AWS A2.4.
 - 4. By the Society for Protective Coatings (SSPC):
 - a. Surface Preparation Specifications.
 - b. Painting System Specifications.
- C. Fabricator's Qualifications:
 - 1. Minimum five years' continuous experience in the fabrication of steel for projects of similar quality and scope.
- D. Erector's Qualifications:
 - 1. Minimum five years' continuous experience in similar steel erection.
- E. Welders' Qualifications: Personnel and procedures are to be qualified in accordance with ANSI/AWS D1.1.
- F. Inspection Agency's Qualifications: Minimum three years' experience in similar steel inspection, and approval of the Architect.

1.4 SUBMITTALS

- A. Certification of Experience: Submit, on request only, written description of personnel, projects, and equipment which document the experience and qualifications required of the fabricator, inspection agency, erector and welders.
- B. Shop Drawings of all structural steel components including erection plans and embedment plans.
 - 1. Indicate all shop and erection details, including cuts, copes, camber, connections, holes, threaded fasteners, and welds.
 - 2. Indicate material specifications and finishes.
 - 3. Indicate shop and field welds with symbols per ANSI/AWS A2.4.
 - 4. Base plate and anchor rod layout may be revised from that shown on the Structural Drawings, including quantity of anchor rods, in order to comply with OSHA requirements, subject to approval by the structural engineer during shop drawing submittals.
- C. Product Data Indicating Proof of Compliance for Materials.
 - 1. Mill test reports for properly identified material for:
 - a. Structural steel shapes.
 - b. High strength threaded fasteners (each type), nuts and washers.
 - c. Direct tension indicators, if used.
 - d. Headed stud connectors.
 - 2. Structural Steel Primer Paint.

3. Shrinkage Resistant, Non-corrosive Grout.

D. Inspection Reports: Submit reports for the inspections specified.

1.5 PRODUCT DELIVERY AND STORAGE

A. Delivery:

1. Comply with ASTM A6. Non-compliance will be cause for rejection.
2. Deliver anchor rods and other items to be embedded in cast-in-place concrete or masonry prior to the start of that work. Provide setting drawings, or directions for installation of anchor rods and other anchorage to be installed as work of other sections.

B. Storage:

1. Store steel at site above ground on platforms, skids or other supports.
2. Protect steel from corrosion.
3. Store fasteners in a protected place. Clean and relubricate bolts and nuts that become dry or rusty.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Rolled Wide Flange Shapes (W):

1. $F_y = 50$ ksi steel: ASTM A992.
2. All material shall be produced domestically.

B. Rolled Shapes (M, S, C and MC), Angles, Plates and Bars:

1. $F_y = 36$ ksi steel: ASTM A36.
2. All material shall be produced domestically.

C. Hollow Structural Sections (HSS):

1. Square/Rectangular: $F_y = 46$ ksi: ASTM A500, Grade B.
2. Round: $F_y = 42$ ksi: ASTM A500, Grade B.
3. All material shall be produced domestically.

D. Pipe: $F_y = 35$ ksi: ASTM A53, Grade B.

E. Fasteners:

1. High Strength Threaded Fasteners:
 - a. Bolts: ASTM A325 or A490, Type 1, heavy hex structural bolts.
 - b. Nuts: ASTM A563.
 - c. Washers: ASTM F436.
2. Anchor Rods, and Threaded Rods: Provide heavy nut and washers for anchor rods (both ends where shown).
 - a. Anchor Rods: ASTM F1554, Grade 36.

- b. Threaded Rods: ASTM A36, $F_y = 36$ ksi.
 - 3. Twist Off, Tension Control Bolts: ASTM F1852.
 - 4. Direct-Tension Indicators: ASTM F959, Type A325 or Type 490, compatible with high strength threaded fasteners.
- F. Welding Electrodes: Conform to requirements of ANSI/AWS D1, using Series E70 electrodes, appropriate for the materials being welded.
 - G. Shop Paint Primer (Gray):
 - 1. SSPC Paint 25, Type II.
 - 2. Galvanized steel to be painted: SSPC Paint 20.
 - 3. Primer to be compatible with finish paint.
 - H. Low-Friction Bearing Pads: TFE bonded to metal backup plate. 2,000 psi bearing capacity. Acceptable products include, but are not limited to:
 - 1. Con-slide Type CSA by Con-Serv, Inc.
 - 2. Fluorogold by Furon.
 - I. Grating: All steel, 1-1/2 inches deep, with 3/16 inch bearing bars. May be welded, pressure-locked or riveted. The following are acceptable:
 - 1. Type 1 by Blaw-Knox Equipment Inc.
 - 2. Type W/B or K by Borden Metal Products Co.
 - 3. Type AA or type M by IKG Industries (Irving).
 - 4. Type 19W4 by Dravo Corporation.
 - 5. Attachment may be by tack welding or saddle clips.
 - J. Headed Stud Connectors: ASTM A108, Grades 1010 through 1020, inclusive, Type B.
 - K. Masonry Anchors: 11 gage channel slots or 3/16-inch diameter wires, shop welded to structural steel.
 - L. Shrinkage Resistant, Non-Corrosive Grout: ASTM C1107/CE-CRD-C621.

2.2 FABRICATION

- A. Conform to applicable provisions of the reference standards listed in Part 1 of this Section, as modified herein.
- B. Columns that are part of the primary skeletal framing system should be fabricated with at least four (4) anchor rods arranged in a square or rectangular orientation in order to comply with OSHA regulations, even if shown with fewer rods on the Contract Drawings.
- C. Connection Design:
 - 1. Design connections per AISC standards for forces and moments given on the Drawings. Where none are given, design for the following:
 - a. For non-composite members use 1/2 of the Allowable Uniform Load on pages 2-37 through 2-140 of the Ninth Edition of the AISC Manual of Steel Construction Allowable Stress Design.

- b. Connections are to be designed and submitted by a Professional Engineer, registered in the State of the project. Calculations are to be submitted with an engineer's seal. Submit connection design calculations for review concurrently with Shop Drawings. In accordance with the AISC Code of Standard Practice, the licensed Professional Engineer in responsible charge of the connection design shall review and confirm in writing that the shop and erection drawings properly incorporate the connection designs. The connection design engineer shall provide a signed and sealed letter verifying this review and confirmation.
 - 2. Connection type is to be:
 - a. Snug-tight joints unless noted otherwise.
 - b. Pre-tensioned or slip-critical joints are required in bolted connections of moment resisting joints/frames, braced frames, joints utilizing both bolts and welds or where specifically shown on the Construction Drawings. Provide twist-off, tension control bolts or direct-tension indicator washers at all locations.
 - 3. Connection details on Drawings are to illustrate location, type, general arrangement only, and to establish minimum requirements.
 - 4. Shop connections may be welded or bolted, unless shown otherwise.
 - 5. Field connections shall be bolted, unless shown otherwise.
- D. Camber: Beams longer than 42 feet are to have minimum camber as follows: 42 - 52 feet, 1 inch; 52 - 65 feet, 2 inches; 65 - 85 feet, 3 inches; unless noted otherwise.
- E. Sweep: Fabricate exterior spandrel beams with the natural sweep toward the interior of the building.
- F. Finishing: Ends of members in direct contact bearing, such as columns at their bases and splices, are to be "finished," as defined in the Code of Standard Practice.
- G. Bearing and Base Plates: Column base plates are to be shop attached. Beam bearing plates may be attached or loose.
- H. Holes: Drill or punch holes in members as required for items of other trades, bolts, passage of conduit and piping, and attachment of joists, nailers, etc. Thermal cutting of such holes is not permitted. If opening is not shown on Structural Drawings, obtain prior approval.
- I. Low-Friction Bearing Pads: Attach to steel per the manufacturer's requirements.

2.3 SHOP CLEANING AND PAINTING

- A. Structural steel that does not require shop paint shall be cleaned of oil and grease with solvent cleaners, and of dirt and other foreign material by sweeping with a fiber brush or other suitable means.
- B. Shop paint all structural steel members, except those members or portion of members to be embedded in concrete or masonry. Paint embedded steel that is partially exposed on

exposed portions and initial 2 inches of embedded areas only.

1. Do not paint surfaces to receive sprayed fire proofing.
 2. Do not paint surfaces to be welded, contact surfaces of slip-critical joints, or members to be galvanized.
- C. Surface Preparation: After inspection and before shipping, clean all steel to be painted. Remove loose rust, loose mill scale, dirt and other foreign matter. Prepare surfaces according to the Society for Protective Coatings (SSPC) as follows:
1. Interior steel concealed from view: SP1 and SP2.
 2. Exterior steel, steel concealed in exterior walls and steel exposed to view: SP6.
- D. Painting: Immediately after surface preparation, apply primer paint in accordance with the Manufacturer's instructions. Use painting methods which will result in full coverage of joints, corners, edges and all exposed surfaces.
1. Interior steel concealed from view shall receive one coat of primer paint with a minimum dry film thickness of 2.0 mils.
 2. Exterior steel, steel concealed in exterior walls and steel exposed to view shall receive two coats of primer paint with a minimum dry film thickness of 2.0 mils, each coat. Change color of second coat to distinguish it from the first.

2.4 GALVANIZING

- A. Where indicated on the Drawings, provide hot-dipped galvanized finish as follows:
1. Structural steel members according to ASTM A123.
 2. Threaded fasteners according to ASTM A153.
- B. Access holes if required for galvanizing shall be shown and labelled on the shop drawings. All access holes shall be permanently sealed prior to erection.

2.5 SOURCE QUALITY CONTROL

- A. The Contractor will engage an independent testing and inspecting agency to perform shop testing and inspections.
1. Provide testing agency with access to perform testing and inspections.
- B. Correct deficiencies in work that test reports and inspections indicate are not in compliance with the Contract Documents.
- C. Shop bolted connections will be inspected according to RCSC'S Specification for Structural Joints using ASTM A325 or A490 bolts.
- D. Shop welded connections will be inspected and tested according to ANSI/AWS D1.1.

PART 3 - EXECUTION

3.1 SURFACE CONDITIONS

- A. Prior to beginning work of this Section, verify that the installed work of other trades is complete and correct to the extent necessary for the proper execution of the work of this Section. This includes locations of anchor rods, and lines and grades of bearings and embedded items.
- B. In the event of discrepancies, immediately notify the Architect. Do not proceed with work affected by the discrepancies until they have been resolved.

3.2 ERECTION

- A. Conform to the applicable provisions of the reference standards listed in Part 1 of this Section, as modified herein.
- B. This structure is designed to be self-supporting and stable after the building is fully completed. It is solely the Contractor's responsibility to determine erection procedures and sequence; and to ensure the stability of the building and its component parts, and the adequacy of temporary or incomplete connections, during erection. This includes the addition of whatever temporary bracing, guys, or tie-downs that might be necessary. Such material is not shown on the Drawings. If applied, they shall be removed as conditions permit, and shall remain the Contractor's property.
- C. Safety: It is solely the Contractor's responsibility to follow all applicable safety codes and regulations governing this work.
- D. Clean bearing surfaces and other surfaces in permanent contact, prior to assembly.
- E. Splices are permitted only where indicated.
- F. Tolerances: Per AISC Code of Standard Practice.
- G. Field corrections of fabrication errors by gas/thermal cutting is not permitted.
- H. Welds which are subject to foot traffic or are exposed to view in the finished structure are to be ground smooth and flush with adjacent surfaces.
- I. Pack grout solidly between bearing surfaces and bases or plates to ensure that no voids remain. Finish exposed edges, protect installed materials and allow to cure.

3.3 FIELD QUALITY CONTROL

- A. Inspection agency shall perform the following:
 - 1. Review qualifications of welders, operators, and welding procedures submitted by the Contractor.
 - 2. Review materials' proofs of compliance, if such are required.
 - 3. Inspect bolted connections, according to RCSC'S Specification for Structural

- Joints using ASTM A325 or A490 bolts.
4. Inspect welded connections per the requirements of ANSI/AWS D1.1, Chapter 6. Welds requiring non-destructive tests are indicated on the Drawings.
 5. Visually inspect connections using twist-off, tension control bolts to verify bolt installation is complete. Verify gaps of direct-tension indicators compressible washers comply with ASTM F959, Table 2.
 6. Testing agency shall submit test reports promptly to the Architect and Contractor.
 7. The Contractor shall correct deficiencies in the work that inspections and reports have indicated are not in compliance with specified requirements. Additional testing will be required to determine compliance of corrected work. Cost of additional testing shall be paid by the Contractor.

3.4 FIELD TOUCH-UP PAINTING

- A. Touch-up painting shall proceed immediately after erection is complete. Clean field welds, bolted connections and abraded areas of shop paint. Do not paint welds until they have been cleaned in accordance with ANSI/AWS D1.1. Apply paint to exposed areas using same product as used for shop painting. Apply by brush or spray to provide a minimum dry film thickness of 2.0 mils.
- B. Galvanizing Repair: Clean field welds, bolted connections and abraded areas and apply galvanizing repair paint according to ASTM A780.

END OF SECTION 051200

SECTION 054000 - COLD-FORMED METAL FRAMING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:

1. Load-bearing wall framing.
2. Exterior non-load-bearing wall framing.
3. Interior non-load-bearing wall framing exceeding height limitations of standard, nonstructural metal framing.
4. Roof rafter framing.
5. Ceiling joist framing.
6. Soffit framing.
7. Roof trusses.

- B. Related Requirements:

1. Section 055000 "Metal Fabrications" for miscellaneous steel shapes, masonry shelf angles, and connections used with cold-formed metal framing.
2. Section 092216 "Non-Structural Metal Framing" for standard, interior non-load-bearing, metal-stud framing, with height limitations and ceiling-suspension assemblies.

1.3 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at (site to be determined, coordinate with Owner's Representative)

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.

- B. Shop Drawings:

1. Include layout, spacings, sizes, thicknesses, and types of cold-formed steel framing; fabrication; and fastening and anchorage details, including mechanical fasteners.
2. Indicate reinforcing channels, opening framing, supplemental framing, strapping, bracing, bridging, splices, accessories, connection details, and attachment to adjoining work.

3. Include structural analysis calculations, sealed by a Professional Engineer, registered in the state of the project, providing for a complete design of members and accessories, including all connections.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For testing agency.
- B. Welding certificates.
- C. Product Certificates: For each type of code-compliance certification for studs and tracks.
- D. Product Test Reports: For each listed product, for tests performed by manufacturer and witnessed by a qualified testing agency, or a qualified testing agency.
 1. Steel sheet.
 2. Expansion anchors.
 3. Power-actuated anchors.
 4. Mechanical fasteners.
 5. Vertical deflection clips.
 6. Horizontal drift deflection clips
 7. Miscellaneous structural clips and accessories.
- E. Evaluation Reports: For nonstandard cold-formed steel framing, post-installed anchors, and power-actuated fasteners, from ICC-ES or other qualified testing agency acceptable to authorities having jurisdiction.

1.6 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Qualified according to ASTM E 329 for testing indicated.
- B. Product Tests: Mill certificates or data from a qualified independent testing agency, or in-house testing with calibrated test equipment, indicating steel sheet complies with requirements, including base-metal thickness, yield strength, tensile strength, total elongation, chemical requirements, and metallic-coating thickness.
- C. Code-Compliance Certification of Studs and Tracks: Provide documentation that framing members are certified according to the product-certification program of the Certified Steel Stud Association, the Steel Framing Industry Association, or the Steel Stud Manufacturers Association.
- D. Welding Qualifications: Qualify procedures and personnel according to the following:
 1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
 2. AWS D1.3/D1.3M, "Structural Welding Code - Sheet Steel."

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A.Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. ClarkDietrich
2. Marino+Ware
3. Steel Construction Systems

2.2 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design cold-formed steel framing.
- B. Structural Performance: Provide cold-formed steel framing capable of withstanding design loads within limits and under conditions indicated.
 1. Design Loads: As indicated on Drawings.
 2. Deflection Limits: Design framing systems to withstand design loads without deflections greater than the following:
 - a. Exterior Load-Bearing Wall Framing: Horizontal deflection of H/240 for walls without an exterior veneer and H/600 for walls with an exterior veneer. (H = the wall height).
 - b. Interior Load-Bearing Wall Framing: Horizontal deflection of H/240 of the wall height under a horizontal load of 5 lbf/sq. ft.
 - c. Exterior Non-Load-Bearing Framing: Horizontal deflection of H/240 of the wall height.
 - d. Interior Non-Load-Bearing Framing: Horizontal deflection of H/240 of the wall height under a horizontal load of 5 lbf/sq. ft.
 - e. Floor Joist Framing: Vertical deflection of L/360 for live loads and 1/240 for total loads of the span.
 - f. Roof Rafter Framing: Vertical deflection of L/360 of the horizontally projected span for live loads.
 - g. Ceiling Joist Framing: Vertical deflection of L/360 of the span for live loads and 1/240 for total loads of the span.
 3. Design framing systems to provide for movement of framing members located outside the insulated building envelope without damage or overstressing, sheathing failure, connection failure, undue strain on fasteners and anchors, or other detrimental effects when subject to a maximum ambient temperature change of 120 deg F (67 deg C).
 4. Design framing system to maintain clearances at openings, to allow for construction tolerances, and to accommodate live load deflection of primary building structure as follows:
 - a. Upward and downward movement of 3/4".

5. Design exterior non-load-bearing wall framing to accommodate horizontal deflection without regard for contribution of sheathing materials.
 6. Design trusses in accordance with AISI "North American Standard for Cold-Formed Steel Framing – Truss Design by the American Iron and Steel Institute.
- C. Cold-Formed Steel Framing Standards: Unless more stringent requirements are indicated, framing shall comply with AISI S100, AISI S200, and the following:
1. Floor and Roof Systems: AISI S210.
 2. Wall Studs: AISI S211.
 3. Headers: AISI S212.
 4. Lateral Design: AISI S213.
- D. Fire-Resistance Ratings: Comply with ASTM E 119; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
1. Indicate design designations from UL's "Fire Resistance Directory" or from the listings of another qualified testing agency acceptable to authorities having jurisdiction.

2.3 COLD-FORMED STEEL FRAMING MATERIALS

- A. Steel Sheet: ASTM A 1003/A 1003M, Structural Grade, Type H, metallic coated, of grade and coating designation as follows:
1. Grade: As required by structural performance.
 2. Coating: G60 or equivalent..
- B. Steel Sheet for Vertical Deflection /Drift Clips: ASTM A 653/A 653M, structural steel, zinc coated, of grade and coating as follows:
1. Grade: As required by structural performance.
 2. Coating: G60.

2.4 LOAD-BEARING WALL FRAMING

- A. Steel Studs: Manufacturer's standard C-shaped steel studs, of web depths indicated, punched, with stiffened flanges, and as follows:
1. Minimum Base-Metal Thickness: 0.0428 inch, minimum.
 2. Flange Width: 1-5/8 inches, minimum.
 3. Section Properties: Per manufacturer's product literature.
- B. Steel Track: Manufacturer's standard U-shaped steel track, of web depths indicated, unpunched, with straight flanges, and as follows:
1. Minimum Base-Metal Thickness: 0.0428 inch, minimum.

2. Flange Width: 1-1/4 inches 32 mm, minimum.
- C. Steel Box or Back-to-Back Headers: Manufacturer's standard C-shapes used to form header beams, of web depths indicated, unpunched, with stiffened flanges, and as follows:
1. Minimum Base-Metal Thickness: 0.0428 inch, minimum.
 2. Flange Width: 1-5/8 inches, minimum.
 3. Section Properties: Per manufacturer's product literature.
- D. Steel Single- or Double-L Headers: Manufacturer's standard L-shapes used to form header beams, of web depths indicated, and as follows:
1. Minimum Base-Metal Thickness: 0.0428 inch, minimum
 2. Top Flange Width: 1-5/8 inches, minimum.
 3. Section Properties: Per manufacturer's product literature.

2.5 EXTERIOR NON-LOAD-BEARING WALL FRAMING

- A. Steel Studs: Manufacturer's standard C-shaped steel studs, of web depths indicated, punched, with stiffened flanges, and as follows:
1. Minimum Base-Metal Thickness: 0.0428 inch, minimum.
 2. Flange Width: 1-5/8 inches, minimum.
 3. Section Properties: Per manufacturer's product literature.
- B. Steel Track: Manufacturer's standard U-shaped steel track, of web depths indicated, unpunched, with unstiffened flanges, and as follows:
1. Minimum Base-Metal Thickness: 0.0428 inch, minimum.
 2. Flange Width: 1-1/4 inches, minimum.
- C. Vertical Deflection Clips: Manufacturer's standard bypass/head clips, capable of accommodating upward and downward vertical displacement of primary structure through positive mechanical attachment to stud web.
1. ClarkDietrich
 2. Marino+Ware
 3. Steel Construction Systems
- D. Single Deflection Track: Manufacturer's single, deep-leg, U-shaped steel track; unpunched, with unstiffened flanges, of web depth to contain studs while allowing free vertical movement, with flanges designed to support horizontal loads and transfer them to the primary structure, and as follows:
1. Minimum Base-Metal Thickness: 0.0428 inch, minimum.
 2. Flange Width: 2 inch, minimum.
- E. Double Deflection Tracks: Manufacturer's double, deep-leg, U-shaped steel tracks, consisting of nested inner and outer tracks; unpunched, with unstiffened flanges.

1. Outer Track: Of web depth to allow free vertical movement of inner track, with flanges designed to support horizontal loads and transfer them to the primary structure, and as follows:
 - a. Minimum Base-Metal Thickness: 0.0428 inch, minimum.
 - b. Flange Width: 2 inch, minimum.
 2. Inner Track: Of web depth indicated, and as follows:
 - a. Minimum Base-Metal Thickness: 0.0428 inch, minimum.
 - b. Flange Width: dimension equal to sum of outer deflection track flange width plus 2 inch, minimum.
- F. Drift Clips: Manufacturer's standard bypass or head clips, capable of isolating wall stud from upward and downward vertical displacement and lateral drift of primary structure through positive mechanical attachment to stud web and structure.

2.6 INTERIOR NON-LOAD-BEARING WALL FRAMING

- A. Steel Studs: Manufacturer's standard C-shaped steel studs, of web depths indicated, punched, with stiffened flanges, and as follows:
1. Minimum Base-Metal Thickness: 0.0329 inch, minimum.
 2. Flange Width: 1-3/8 inches, minimum.
 3. Section Properties: Per manufacturer's product literature.
- B. Steel Track: Manufacturer's standard U-shaped steel track, of web depths indicated, unpunched, with unstiffened flanges, and as follows:
1. Minimum Base-Metal Thickness: 0.0329 inch, minimum.
 2. Flange Width: 1-1/4 inches, minimum.
- C. Vertical Deflection Clips: Manufacturer's standard bypass/head clips, capable of accommodating upward and downward vertical displacement of primary structure through positive mechanical attachment to stud web.
1. ClarkDietrich
 2. Marino+Ware
 3. Steel Construction Systems
- D. Single Deflection Track: Manufacturer's single, deep-leg, U-shaped steel track; unpunched, with unstiffened flanges, of web depth to contain studs while allowing free vertical movement, with flanges designed to support horizontal loads and transfer them to the primary structure, and as follows:
1. Minimum Base-Metal Thickness: 0.0428 inch, minimum.
 2. Flange Width: 2 inch, minimum.
- E. Double Deflection Tracks: Manufacturer's double, deep-leg, U-shaped steel tracks, consisting of nested inner and outer tracks; unpunched, with unstiffened flanges.

1. Outer Track: Of web depth to allow free vertical movement of inner track, with flanges designed to support horizontal loads and transfer them to the primary structure, and as follows:
 - a. Minimum Base-Metal Thickness: 0.0329 inch, minimum.
 - b. Flange Width: 1 inch, minimum.
 2. Inner Track: Of web depth indicated, and as follows:
 - a. Minimum Base-Metal Thickness: 0.0428 inch, minimum.
 - b. Flange Width: dimension equal to sum of outer deflection track flange width plus 1 inch, minimum.
- F. Drift Clips: Manufacturer's standard bypass or head clips, capable of isolating wall stud from upward and downward vertical displacement and lateral drift of primary structure through positive mechanical attachment to stud web and structure.

2.7 FLOOR JOIST FRAMING

- A. Steel Joists: Manufacturer's standard C-shaped steel joists, of web depths indicated, unpunched with stiffened flanges, and as follows:
1. Minimum Base-Metal Thickness: 0.0428 inch, minimum.
 2. Flange Width: 1-5/8 inches, minimum.
 3. Section Properties: Per manufacturer's product literature.
- B. Steel Joist Track: Manufacturer's standard U-shaped steel joist track, of web depths indicated, unpunched, with unstiffened flanges, and as follows:
1. Minimum Base-Metal Thickness: 0.0428 inch, minimum.
 2. Flange Width: 1-1/2 inches, minimum.

2.8 ROOF-RAFTER FRAMING

- A. Steel Rafters: Manufacturer's standard C-shaped steel sections, of web depths indicated, with stiffened flanges, and as follows:
1. Minimum Base-Metal Thickness: 0.0428 inch, minimum.
 2. Flange Width: 1-5/8 inches, minimum.
 3. Section Properties: Per manufacturer's product literature.

2.9 TRUSSES

- A. Use Manufacturer's standard shapes, unpunched, with stiffened flanges.

2.10 CEILING JOIST FRAMING

- A. Steel Ceiling Joists: Manufacturer's standard C-shaped steel sections, of web depths indicated, unpunched with stiffened flanges, and as follows:
 - 1. Minimum Base-Metal Thickness: 0.0329 inch, minimum.
 - 2. Flange Width: 1-5/8 inches, minimum.
 - 3. Section Properties: Refer to manufacturer's product literature.

2.11 SOFFIT FRAMING

- A. Exterior Soffit Frame: Manufacturer's standard C-shaped steel sections, of web depths indicated, with stiffened flanges, and as follows:
 - 1. Minimum Base-Metal Thickness: 0.0329 inch, minimum.
 - 2. Flange Width: 1-5/8 inches, minimum.
 - 3. Section Properties: Refer to manufacturer's product literature.

2.12 FRAMING ACCESSORIES

- A. Fabricate steel-framing accessories from ASTM A 1003/A 1003M, Structural Grade, Type H, metallic coated steel sheet, of same grade and coating designation used for framing members.
- B. Provide accessories of manufacturer's standard thickness and configuration, unless otherwise indicated, as follows:
 - 1. Supplementary framing.
 - 2. Bracing, bridging, and solid blocking.
 - 3. Web stiffeners.
 - 4. Anchor clips.
 - 5. End clips.
 - 6. Foundation clips.
 - 7. Gusset plates.
 - 8. Stud kickers and knee braces.
 - 9. Joist hangers and end closures.
 - 10. Hole-reinforcing plates.
 - 11. Backer plates.

2.13 ANCHORS, CLIPS, AND FASTENERS

- A. Steel Shapes and Clips: ASTM A 36/A 36M, zinc coated by hot-dip process according to ASTM A 123/A 123M.
- B. Anchor Bolts: ASTM F 1554, Grade 36, minimum, threaded carbon-steel hex-headed bolts, headless, hooked bolts, headless bolts, with encased end threaded, carbon-steel nuts, and flat, hardened-steel washers; zinc coated by hot-dip process according to ASTM A 153/A 153M, Class C

- C. Post-Installed Anchors: Fastener systems with bolts of same basic metal as fastened metal, if visible, unless otherwise indicated; with working capacity greater than or equal to the design load, according to an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES AC01, ICC-ES AC193, ICC-ES AC58, or ICC-ES AC308 as appropriate for the substrate.
 - 1. Uses: Securing cold-formed steel framing to structure.
 - 2. Type: Torque-controlled expansion anchor, Torque-controlled adhesive anchor, or adhesive anchor as listed on the Drawings.
 - 3. Material for Interior Locations: Carbon-steel components zinc plated to comply with ASTM B 633 or ASTM F 1941 (ASTM F 1941M), Class Fe/Zn 5, unless otherwise indicated.
 - 4. Material for Exterior or Interior Locations and Where Stainless Steel Is Indicated: Alloy [Group 1 (A1)] stainless-steel bolts, ASTM F 593 (ASTM F 738M), and nuts, ASTM F 594 (ASTM F 836M).
- D. Power-Actuated Anchors: Fastener systems with working capacity greater than or equal to the design load, according to an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES AC70.
- E. Mechanical Fasteners: ASTM C 1513, corrosion-resistant-coated, self-drilling, self-tapping, steel drill screws.
 - 1. Head Type: Low-profile head beneath sheathing; manufacturer's standard elsewhere.
- F. Welding Electrodes: Comply with AWS standards.

2.14 MISCELLANEOUS MATERIALS

- A. Galvanizing Repair Paint: ASTM A 780/A 780M, MIL-P-21035B, or SSPC-Paint 20.
- B. Cement Grout: Portland cement, ASTM C 150/C 150M, Type I; and clean, natural sand, ASTM C 404. Mix at ratio of 1 part cement to 2-1/2 parts sand, by volume, with minimum water required for placement and hydration.
- C. Nonmetallic, Nonshrink Grout: Factory-packaged, nonmetallic, noncorrosive, nonstaining grout, complying with ASTM C 1107/C 1107M, and with a fluid consistency and 30-minute working time.
- D. Shims: Load-bearing, high-density, multimonomer, nonleaching plastic; or cold-formed steel of same grade and metallic coating as framing members supported by shims.
- E. Sealer Gaskets: Closed-cell neoprene foam, 1/4 inch (6 mm) thick, selected from manufacturer's standard widths to match width of bottom track or rim track members as required.

2.15 FABRICATION

- A. Fabricate cold-formed steel framing and accessories plumb, square, and true to line, and with connections securely fastened, according to referenced AISI's specifications and standards, manufacturer's written instructions, and requirements in this Section.
 - 1. Fabricate framing assemblies using jigs or templates.
 - 2. Cut framing members by sawing or shearing; do not torch cut.
 - 3. Fasten cold-formed steel framing members by welding, screw fastening, clinch fastening, pneumatic pin fastening, or riveting as standard with fabricator. Wire tying of framing members is not permitted.
 - a. Comply with AWS D1.3/D1.3M requirements and procedures for welding, appearance and quality of welds, and methods used in correcting welding work.
 - b. Locate mechanical fasteners and install according to Shop Drawings, with screws penetrating joined members by no fewer than three exposed screw threads.
 - 4. Fasten other materials to cold-formed steel framing by welding, bolting, pneumatic pin fastening, or screw fastening, according to Shop Drawings.
- B. Reinforce, stiffen, and brace framing assemblies to withstand handling, delivery, and erection stresses. Lift fabricated assemblies by means that prevent damage or permanent distortion.
- C. Tolerances: Fabricate assemblies level, plumb, and true to line to a maximum allowable variation of 1/8 inch in 10 feet (1:960) and as follows:
 - 1. Spacing: Space individual framing members no more than plus or minus 1/8 inch (3 mm) from plan location. Cumulative error shall not exceed minimum fastening requirements of sheathing or other finishing materials.
 - 2. Squareness: Fabricate each cold-formed steel framing assembly to a maximum out-of-square tolerance of 1/8 inch (3 mm).
- D. Trusses: overall profiles, dimensions, work points, slopes and loadings are shown the Drawings. Provide Manufacturer's standard steel truss members, bracing, bridging, blocking, reinforcements, fasteners and accessories for each type of truss required, as recommended by the manufacturer for the applications indicated and as needed to provide a complete cold-formed steel truss system.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, conditions, and abutting structural framing for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Before sprayed fire-resistive materials are applied, attach continuous angles, supplementary framing, or tracks to structural members indicated to receive sprayed fire-resistive materials.
- B. After applying sprayed fire-resistive materials, remove only as much of these materials as needed to complete installation of cold-formed framing without reducing thickness of fire-resistive materials below that required to obtain fire-resistance ratings indicated. Protect remaining fire-resistive materials from damage.
- C. Install load-bearing shims or grout between the underside of load-bearing wall bottom track and the top of foundation wall or slab at locations with a gap larger than 1/4 inch (6 mm) to ensure a uniform bearing surface on supporting concrete or masonry construction.
- D. Install sealer gaskets at the underside of wall bottom track or rim track and at the top of foundation wall or slab at stud or joist locations.

3.3 INSTALLATION, GENERAL

- A. Cold-formed steel framing may be shop or field fabricated for installation, or it may be field assembled.
- B. Install cold-formed steel framing according to AISI S200, AISI S202, and manufacturer's written instructions unless more stringent requirements are indicated.
- C. Install shop- or field-fabricated, cold-formed framing and securely anchor to supporting structure.
 - 1. Screw, bolt, or weld wall panels at horizontal and vertical junctures to produce flush, even, true-to-line joints with maximum variation in plane and true position between fabricated panels not exceeding 1/16 inch (1.6 mm).
- D. Install cold-formed steel framing and accessories plumb, square, and true to line, and with connections securely fastened.
 - 1. Cut framing members by sawing or shearing; do not torch cut.
 - 2. Fasten cold-formed steel framing members by welding, screw fastening, clinch fastening, or riveting. Wire tying of framing members is not permitted.
 - a. Comply with AWS D1.3/D1.3M requirements and procedures for welding, appearance and quality of welds, and methods used in correcting welding work.
 - b. Locate mechanical fasteners, install according to Shop Drawings, and comply with requirements for spacing, edge distances, and screw penetration.

- E. Install framing members in one-piece lengths unless splice connections are indicated for track or tension members.
- F. Install temporary bracing and supports to secure framing and support loads equal to those for which structure was designed. Maintain braces and supports in place, undisturbed, until entire integrated supporting structure has been completed and permanent connections to framing are secured.
- G. Do not bridge building expansion joints with cold-formed steel framing. Independently frame both sides of joints.
- H. Install insulation, specified in Section 072100 "Thermal Insulation," in framing-assembly members, such as headers, sills, boxed joists, and multiple studs at openings, that are inaccessible on completion of framing work.
- I. Fasten hole-reinforcing plate over web penetrations that exceed size of manufacturer's approved or standard punched openings.

3.4 LOAD-BEARING WALL INSTALLATION

- A. Install continuous top and bottom tracks sized to match studs. Align tracks accurately and securely anchor at corners and ends, and at spacings as follows:
 - 1. Anchor Spacing: As shown on Shop Drawings.
- B. Squarely seat studs against top and bottom tracks, with gap not exceeding 1/8 inch (3 mm) between the end of wall-framing member and the web of track. Fasten both flanges of studs to top and bottom tracks. Space studs as follows:
 - 1. Stud Spacing: As indicated on Drawings.
 - 2. Stud Spacing: As indicated on Drawings.
- C. Set studs plumb, except as needed for diagonal bracing or required for non-plumb walls or warped surfaces and similar configurations.
- D. Align studs vertically where floor framing interrupts wall-framing continuity. Where studs cannot be aligned, continuously reinforce track to transfer loads.
- E. Align floor and roof framing over studs according to AISI S200, Section C1. Where framing cannot be aligned, continuously reinforce track to transfer loads.
- F. Anchor studs abutting structural columns or walls, including masonry walls, to supporting structure.
- G. Install headers over wall openings wider than stud spacing. Locate headers above openings. Fabricate headers of compound shapes indicated or required to transfer load to supporting studs, complete with clip-angle connectors, web stiffeners, or gusset plates.
 - 1. Frame wall openings with not less than a double stud at each jamb of frame. Fasten jamb members together to uniformly distribute loads.

2. Install tracks and jack studs above and below wall openings. Anchor tracks to jamb studs with clip angles or by welding, and space jack studs same as full-height wall studs.
- H. Install supplementary framing, blocking, and bracing in stud framing indicated to support fixtures, equipment, services, casework, heavy trim, furnishings, and similar work requiring attachment to framing.
1. If type of supplementary support is not indicated, comply with stud manufacturer's written recommendations and industry standards in each case, considering weight or load resulting from item supported.
- I. Install horizontal bridging in stud system, spaced vertically as indicated on Shop Drawings. Fasten at each stud intersection.
1. Channel Bridging: Cold-rolled steel channel, welded or mechanically fastened to webs of punched studs with a minimum of two screws into each flange of the clip angle for framing members up to 6 inches (150 mm) deep.
 2. Strap Bridging: Combination of flat, taut, steel sheet straps of width and thickness indicated and stud-track solid blocking of width and thickness to match studs. Fasten flat straps to stud flanges, and secure solid blocking to stud webs or flanges.
 3. Bar Bridging: Proprietary bridging bars installed according to manufacturer's written instructions.
- J. Install steel sheet diagonal bracing straps to both stud flanges; terminate at and fasten to reinforced top and bottom tracks. Fasten clip-angle connectors to multiple studs at ends of bracing and anchor to structure.
- K. Install miscellaneous framing and connections, including supplementary framing, web stiffeners, clip angles, continuous angles, anchors, and fasteners, to provide a complete and stable wall-framing system.

3.5 EXTERIOR NON-LOAD-BEARING WALL INSTALLATION

- A. Install continuous tracks sized to match studs. Align tracks accurately and securely anchor to supporting structure.
- B. Fasten both flanges of studs to top and bottom track unless otherwise indicated. Space studs as follows:
1. Stud Spacing: As indicated on Drawings.
 2. Stud Spacing: As indicated on Drawings.
- C. Set studs plumb, except as needed for diagonal bracing or required for non-plumb walls or warped surfaces and similar requirements.
- D. Isolate non-load-bearing steel framing from building structure to prevent transfer of vertical loads while providing lateral support.
1. Install single deep-leg deflection tracks and anchor to building structure.

2. Install double deep-leg deflection tracks and anchor outer track to building structure.
 3. Connect vertical deflection clips to bypassing/infill studs and anchor to building structure.
 4. Connect drift clips to cold-formed steel framing and anchor to building structure.
- E. Install horizontal bridging in wall studs, spaced vertically in rows indicated on Shop Drawings but not more than 48 inches apart. Fasten at each stud intersection.
1. Channel Bridging: Cold-rolled steel channel, welded or mechanically fastened to webs of punched studs.
 2. Strap Bridging: Combination of flat, taut, steel sheet straps of width and thickness indicated and stud-track solid blocking of width and thickness to match studs. Fasten flat straps to stud flanges and secure solid blocking to stud webs or flanges.
 3. Bar Bridging: Proprietary bridging bars installed according to manufacturer's written instructions.
- F. Top Bridging for Single Deflection Track: Install row of horizontal bridging within 12 inches of single deflection track. Install a combination of bridging and stud or stud-track solid blocking of width and thickness matching studs, secured to stud webs or flanges.
1. Install solid blocking at centers indicated on Shop Drawings.
- G. Install miscellaneous framing and connections, including stud kickers, web stiffeners, clip angles, continuous angles, anchors, and fasteners, to provide a complete and stable wall-framing system.

3.6 INTERIOR NON-LOAD-BEARING WALL INSTALLATION

- A. Install continuous tracks sized to match studs. Align tracks accurately and securely anchor to supporting structure.
- B. Fasten both flanges of studs to **top and** bottom track unless otherwise indicated. Space studs as follows:
1. Stud Spacing: As indicated on Drawings.
 2. Stud Spacing: As indicated on Drawings.
- C. Set studs plumb, except as needed for diagonal bracing or required for non-plumb walls or warped surfaces and similar requirements.
- D. Isolate non-load-bearing steel framing from building structure to prevent transfer of vertical loads while providing lateral support.
1. Install single deep-leg deflection tracks and anchor to building structure.
 2. Install double deep-leg deflection tracks and anchor outer track to building structure.
 3. Connect vertical deflection clips to studs and anchor to building structure.
 4. Connect drift clips to cold-formed steel metal framing and anchor to building structure.

- E. Install horizontal bridging in wall studs, spaced vertically in rows indicated on Shop Drawings but not more than 48 inches apart. Fasten at each stud intersection.
 - 1. Channel Bridging: Cold-rolled steel channel, welded or mechanically fastened to webs of punched studs.
 - 2. Strap Bridging: Combination of flat, taut, steel sheet straps of width and thickness indicated and stud-track solid blocking of width and thickness to match studs. Fasten flat straps to stud flanges and secure solid blocking to stud webs or flanges.
 - 3. Bar Bridging: Proprietary bridging bars installed according to manufacturer's written instructions.
- F. Top Bridging for Single Deflection Track: Install row of horizontal bridging within 12 inches of single deflection track. Install a combination of bridging and stud or stud-track solid blocking of width and thickness matching studs, secured to stud webs or flanges.
 - 1. Install solid blocking at centers indicated on Shop Drawings.
- G. Install miscellaneous framing and connections, including stud kickers, web stiffeners, clip angles, continuous angles, anchors, and fasteners, to provide a complete and stable wall-framing system.

3.7 TRUSSES

- A. Locate trusses directly over bearing studs or provide a load distribution member at the top track. Load distribution member to be designed by the truss manufacturer. Anchor trusses securely at all bearing points.
- B. Provide and install lateral bridging and/or bracing support at truss members and panel points as shown on the Shop Drawings.

3.8 JOIST INSTALLATION

- A. Install perimeter joist track sized to match joists. Align and securely anchor or fasten track to supporting structure at corners, ends, and spacings indicated on Shop Drawings.
- B. Install joists bearing on supporting frame, level, straight, and plumb; adjust to final position, brace, and reinforce. Fasten joists to both flanges of joist track.
 - 1. Install joists over supporting frame with a minimum end bearing of 1-1/2 inches (38 mm).
 - 2. Reinforce ends and bearing points of joists with web stiffeners, end clips, joist hangers, steel clip angles, or steel-stud sections.
- C. Space joists not more than 2 inches (51 mm) from abutting walls, and as follows:
 - 1. Joist Spacing: As indicated on Drawings.
 - 2. Joist Spacing: As indicated on Drawings.
- D. Frame openings with built-up joist headers, consisting of joist and joist track or another combination of connected joists if indicated.

- E. Install joist reinforcement at interior supports with single, short length of joist section located directly over interior support, with lapped joists of equal length to joist reinforcement.
 - 1. Install web stiffeners to transfer axial loads of walls above.
- F. Install bridging at intervals indicated **on** Shop Drawings. Fasten bridging at each joist intersection as follows:
 - 1. Joist-Track Solid Bridging: Joist-track solid blocking of width and thickness indicated, secured to joist webs.
 - 2. Combination Bridging: Combination of flat, taut, steel sheet straps of width and thickness indicated and joist-track solid blocking of width and thickness indicated. Fasten flat straps to bottom flange of joists and secure solid blocking to joist webs.
- G. Secure joists to load-bearing interior walls to prevent lateral movement of bottom flange.
- H. Install miscellaneous joist framing and connections, including web stiffeners, closure pieces, clip angles, continuous angles, hold-down angles, anchors, and fasteners, to provide a complete and stable joist-framing assembly.

3.9 ERECTION TOLERANCES

- A. Install cold-formed steel framing level, plumb, and true to line to a maximum allowable tolerance variation of 1/8 inch in 10 feet (1:960) and as follows:
 - 1. Space individual framing members no more than plus or minus 1/8 inch from plan location. Cumulative error shall not exceed minimum fastening requirements of sheathing or other finishing materials.

3.10 FIELD QUALITY CONTROL

- A. Testing: Owner will engage a qualified independent testing and inspecting agency to perform field tests and inspections and prepare test reports.
- B. Field and shop welds will be subject to testing and inspecting.
- C. Testing agency will report test results promptly and in writing to Contractor and Architect.
- D. Cold-formed steel framing will be considered defective if it does not pass tests and inspections.
- E. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

3.11 REPAIRS AND PROTECTION

- A. Galvanizing Repairs: Prepare and repair damaged galvanized coatings on fabricated and installed cold-formed steel framing with galvanized repair paint according to ASTM A 780/A 780M and manufacturer's written instructions.
- B. Provide final protection and maintain conditions, in a manner acceptable to manufacturer and Installer, that ensure that cold-formed steel framing is without damage or deterioration at time of Substantial Completion.

END OF SECTION 054000

SECTION 055000 - METAL FABRICATIONS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification Sections, apply to work of this section.

1.2 SUMMARY

- A. Section Includes:

- 1. Miscellaneous framing and supports.
- 2. Metal bollards.

- B. Products furnished, but not installed, under this Section include the following:

- 1. Steel weld plates and angles for casting into concrete for applications where they are not specified in other Sections.
- 2. Anchor bolts, steel pipe sleeves, slotted-channel inserts, and wedge-type inserts indicated to be cast into concrete or built into unit masonry.

- C. Related Requirements:

- 1. Section 042000 "Unit Masonry" for installing loose lintels, anchor bolts, and other items built into unit masonry.
- 2. Section 051200 "Structural Steel Framing" for steel framing, supports, elevator machine beams, hoist beams, divider beams, door frames, and other steel items attached to the structural-steel framing.
- 3. Section 077200 "Roof Accessories" for manufactured metal roof walkways and metal roof stairs.

1.3 COORDINATION

- A. Coordinate selection of shop primers with topcoats to be applied over them. Comply with paint and coating manufacturers' written instructions to ensure that shop primers and topcoats are compatible with one another.
- B. Coordinate installation of metal fabrications that are anchored to or that receive other work. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.

1.4 ACTION SUBMITTALS

- A. Product Data:

- 1. Fasteners.

2. Shrinkage-resisting grout.
 3. Metal bollards.
- B. Shop Drawings: Show fabrication and installation details. Provide Shop Drawings for the following:
1. Miscellaneous framing and supports for applications where framing and supports are not specified in other Sections.
 2. Miscellaneous steel trim including steel channel jamb guards and steel edgings.
 3. Metal bollards.

1.5 INFORMATIONAL SUBMITTALS

- A. Mill Certificates: Signed by stainless steel manufacturers, certifying that products furnished comply with requirements.
- B. Welding certificates.
- C. Paint Compatibility Certificates: From manufacturers of topcoats applied over shop primers, certifying that shop primers are compatible with topcoats.
- D. Research Reports: For post-installed anchors.
- E. Delegated design engineer qualifications.

1.6 QUALITY ASSURANCE

- A. Welding Qualifications: Qualify procedures and personnel in accordance with the following welding codes:
 1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
 2. AWS D1.2/D1.2M, "Structural Welding Code - Aluminum."
 3. AWS D1.6/D1.6M, "Structural Welding Code - Stainless Steel."

PART 2 - PRODUCTS

2.1 METALS

- A. Metal Surfaces, General: Provide materials with smooth, flat surfaces unless otherwise indicated. For metal fabrications exposed to view in the completed Work, provide materials without seam marks, roller marks, rolled trade names, or blemishes.
- B. Steel Plates, Shapes, and Bars: ASTM A36/A36M.
- C. Steel Tubing: ASTM A500/A500M, cold-formed steel tubing.
- D. Aluminum Plate and Sheet: ASTM B209, Alloy 6061-T6.
- E. Aluminum Extrusions: ASTM B221, Alloy 6063-T6.

- F. Aluminum-Alloy Rolled Tread Plate: ASTM B632/B632M, Alloy 6061-T6.
- G. Aluminum Castings: ASTM B26/B26M, Alloy 443.0-F.

2.2 FASTENERS

- A. General: Unless otherwise indicated, provide Type 316 stainless steel fasteners for exterior use and zinc-plated fasteners with coating complying with ASTM B633 or ASTM F1941/F1941M, Class Fe/Zn 5, at exterior walls. Select fasteners for type, grade, and class required.
 - 1. Provide stainless steel fasteners for fastening aluminum or stainless steel.
- B. Steel Bolts and Nuts: Regular hexagon-head bolts, ASTM A307, Grade A; with hex nuts, ASTM A563; and, where indicated, flat washers.
- C. High-Strength Bolts, Nuts, and Washers: ASTM F3125/F3125M, Grade A325, Type 3, heavy-hex steel structural bolts; ASTM A563, Grade DH3, heavy-hex carbon-steel nuts; and where indicated, flat washers.
- D. Stainless Steel Bolts and Nuts: Regular hexagon-head annealed stainless steel bolts, ASTM F593; with hex nuts, ASTM F594; and, where indicated, flat washers; Alloy Group 2.
- E. Anchor Bolts: ASTM F1554, Grade 36, of dimensions indicated; with nuts, ASTM A563; and, where indicated, flat washers.
 - 1. Hot-dip galvanize or provide mechanically deposited, zinc coating where item being fastened is indicated to be galvanized.
- F. Anchors, General: Capable of sustaining, without failure, a load equal to six times the load imposed when installed in unit masonry and four times the load imposed when installed in concrete, as determined by testing in accordance with ASTM E488/E488M, conducted by a qualified independent testing agency.
- G. Cast-in-Place Anchors in Concrete: Either threaded or wedge type unless otherwise indicated; galvanized ferrous castings, either ASTM A47/A47M malleable iron or ASTM A27/A27M cast steel. Provide bolts, washers, and shims as needed, all hot-dip galvanized per ASTM F2329/F2329M.
- H. Post-Installed Anchors: Torque-controlled expansion anchors or chemical anchors.
 - 1. Material for Exterior Locations and Where Stainless Steel Is Indicated: Alloy Group 2 stainless steel bolts, ASTM F593, and nuts, ASTM F594.

2.3 MISCELLANEOUS MATERIALS

- A. Shop Primers: Provide primers that comply with Section 099113 "Exterior Painting" and Section 099123 "Interior Painting"
- B. Water-Based Primer: Emulsion type, anticorrosive primer for mildly corrosive environments that is resistant to flash rusting when applied to cleaned steel, complying

with MPI#107 and compatible with topcoat.

- C. Epoxy Zinc-Rich Primer: Complying with MPI#20 and compatible with topcoat.
- D. Shop Primer for Galvanized Steel: Primer formulated for exterior use over zinc-coated metal and compatible with finish paint systems indicated.
- E. Galvanizing Repair Paint: High-zinc-dust-content paint complying with SSPC-Paint 20 and compatible with paints specified to be used over it.
- F. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D1187/D1187M.
- G. Shrinkage-Resistant Grout: Factory-packaged, nonmetallic, nonstaining, noncorrosive, nongaseous grout complying with ASTM C1107/C1107M. Provide grout specifically recommended by manufacturer for interior and exterior applications.
- H. Concrete: Comply with requirements in Section 033000 "Cast-in-Place Concrete" for normal-weight, air-entrained concrete with a minimum 28-day compressive strength of 3000 psi.

2.4 FABRICATION, GENERAL

- A. Shop Assembly: Preassemble items in the shop to greatest extent possible. Disassemble units only as necessary for shipping and handling limitations. Use connections that maintain structural value of joined pieces. Clearly mark units for reassembly and coordinated installation.
- B. Cut, drill, and punch metals cleanly and accurately. Remove burrs and ease edges to a radius of approximately 1/32 inch unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.
- C. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing work.
- D. Form exposed work with accurate angles and surfaces and straight edges.
- E. Weld corners and seams continuously to comply with the following:
 - 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
 - 2. Obtain fusion without undercut or overlap.
 - 3. Remove welding flux immediately.
 - 4. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.
- F. Form exposed connections with hairline joints, flush and smooth, using concealed fasteners or welds where possible. Where exposed fasteners are required, use Phillips flat-head (countersunk) fasteners unless otherwise indicated. Locate joints where least conspicuous.

- G. Fabricate seams and other connections that are exposed to weather in a manner to exclude water. Provide weep holes where water may accumulate.
- H. Cut, reinforce, drill, and tap metal fabrications as indicated to receive finish hardware, screws, and similar items.
- I. Provide for anchorage of type indicated; coordinate with supporting structure. Space anchoring devices to secure metal fabrications rigidly in place and to support indicated loads.
- J. Where units are indicated to be cast into concrete or built into masonry, equip with integrally welded steel strap anchors, 1/8 by 1-1/2 inches, with a minimum 6-inch embedment and 2-inch hook, not less than 8 inches from ends and corners of units and 24 inches o.c., unless otherwise indicated.

2.5 MISCELLANEOUS FRAMING AND SUPPORTS

- A. General: Provide framing and supports of compatible materials not specified in other Sections as needed to complete the Work.
- B. Fabricate steel pipe columns for supporting wood frame construction from steel pipe with steel baseplates and top plates as indicated. Drill or punch baseplates and top plates for anchor and connection bolts and weld to pipe with fillet welds all around. Make welds the same size as pipe wall thickness unless otherwise indicated.
 - 1. Unless otherwise indicated, fabricate from Schedule 40 steel pipe.
 - 2. Unless otherwise indicated, provide 1/2-inch baseplates with four 5/8-inch anchor bolts and 1/4-inch top plates.
- C. Galvanize miscellaneous framing and supports where indicated.
- D. Prime miscellaneous framing and supports with zinc-rich primer where indicated.

2.6 METAL BOLLARDS

- A. Fabricate metal bollards from Schedule 80 steel pipe.
- B. Prime steel bollards with zinc-rich primer.

2.7 LOOSE BEARING AND LEVELING PLATES

- A. Provide loose bearing and leveling plates for steel items bearing on masonry or concrete construction. Drill plates to receive anchor bolts and for grouting.
- B. Galvanize bearing and leveling plates.
- C. Prime plates with zinc-rich primer.

2.8 STEEL WELD PLATES AND ANGLES

- A. Provide steel weld plates and angles not specified in other Sections, for items supported from concrete construction as needed to complete the Work. Provide each unit with no fewer than two integrally welded steel strap anchors for embedding in concrete.

2.9 GENERAL FINISH REQUIREMENTS

- A. Finish metal fabrications after assembly.
- B. Finish exposed surfaces to remove tool and die marks and stretch lines, and to blend into surrounding surface.

2.10 STEEL AND IRON FINISHES

- A. Galvanizing: Hot-dip galvanize items as indicated to comply with ASTM A153/A153M for steel and iron hardware and with ASTM A123/A123M for other steel and iron products.
 - 1. Do not quench or apply post galvanizing treatments that might interfere with paint adhesion.
- B. Preparation for Shop Priming Galvanized Items: After galvanizing, thoroughly clean galvanized surfaces of grease, dirt, oil, flux, and other foreign matter, and treat with metallic phosphate process.
- C. Shop prime iron and steel items not indicated to be galvanized unless they are to be embedded in concrete, sprayed-on fireproofing, or masonry, or unless otherwise indicated.
- D. Preparation for Shop Priming: Prepare surfaces to comply with requirements indicated below:
 - 1. Exterior Items: SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
 - 2. Items Indicated to Receive Zinc-Rich Primer: SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
 - 3. Other Steel Items: SSPC-SP 3, "Power Tool Cleaning."
 - 4. Galvanized-Steel Items: SSPC-SP 16, "Brush-off Blast Cleaning of Coated and Uncoated Galvanized Steel, Stainless Steels, and Non-Ferrous Metals."
- E. Shop Priming: Apply shop primer to comply with SSPC-PA 1, "Paint Application Specification No. 1: Shop, Field, and Maintenance Painting of Steel," for shop painting.

2.11 ALUMINUM FINISHES

- A. As-Fabricated Finish: AA-M12.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

- A. Cutting, Fitting, and Placement: Perform cutting, drilling, and fitting required for installing metal fabrications. Set metal fabrications accurately in location, alignment, and elevation; with edges and surfaces level, plumb, true, and free of rack; and measured from established lines and levels.
- B. Fit exposed connections accurately together to form hairline joints. Weld connections that are not to be left as exposed joints but cannot be shop welded because of shipping size limitations. Do not weld, cut, or abrade surfaces of exterior units that have been hot-dip galvanized after fabrication and are for bolted or screwed field connections.
- C. Field Welding: Comply with the following requirements:
 - 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
 - 2. Obtain fusion without undercut or overlap.
 - 3. Remove welding flux immediately.
 - 4. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.
- D. Fastening to In-Place Construction: Provide anchorage devices and fasteners where metal fabrications are required to be fastened to in-place construction. Provide threaded fasteners for use with concrete and masonry inserts, toggle bolts, through bolts, lag screws, wood screws, and other connectors.
- E. Provide temporary bracing or anchors in formwork for items that are to be built into concrete, masonry, or similar construction.
- F. Corrosion Protection: Coat concealed surfaces of aluminum that come into contact with grout, concrete, masonry, wood, or dissimilar metals with the following:
 - 1. Cast Aluminum: Heavy coat of bituminous paint.
 - 2. Extruded Aluminum: Two coats of clear lacquer.

3.2 INSTALLATION OF MISCELLANEOUS FRAMING AND SUPPORTS

- A. General: Install framing and supports to comply with requirements of items being supported, including manufacturers' written instructions and requirements indicated on Shop Drawings.
- B. Anchor supports for overhead doors securely to, and rigidly brace from, building structure.
- C. Support steel girders on solid grouted masonry, concrete, or steel pipe columns. Secure girders with anchor bolts embedded in grouted masonry or concrete or with bolts through top plates of pipe columns.

1. Where grout space under bearing plates is indicated for girders supported on concrete or masonry, install as specified in Section 3.4 below.

3.3 INSTALLATION OF METAL BOLLARDS

- A. Anchor bollards in place with concrete footings. Center and align bollards in holes 3 inches above bottom of excavation. Place concrete and vibrate or tamp for consolidation. Support and brace bollards in position until concrete has cured.
- B. Fill bollards solidly with concrete, mounding top surface to shed water.

3.4 INSTALLATION OF LOOSE BEARING AND LEVELING PLATES

- A. Clean concrete and masonry bearing surfaces of bond-reducing materials, and roughen to improve bond to surfaces. Clean bottom surface of plates.
- B. Set bearing and leveling plates on wedges, shims, or leveling nuts. After bearing members have been positioned and plumbed, tighten anchor bolts. Do not remove wedges or shims but, if protruding, cut off flush with edge of bearing plate before packing with shrinkage-resistant grout. Pack grout solidly between bearing surfaces and plates to ensure that no voids remain.

3.5 REPAIRS

- A. Touchup Painting:
 1. Immediately after erection, clean field welds, bolted connections, and abraded areas. Paint uncoated and abraded areas with same material as used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.
 - a. Apply by brush or spray to provide a minimum 2.0-mil dry film thickness.
- B. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A780/A780M.

END OF SECTION 055000

SECTION 055100 – ALUMINUM LADDERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification Sections, apply to work of this section.

1.2 DESCRIPTION OF WORK

- A. The Contractor, under this section, shall provide and install aluminum ladders as shown on the Drawings or as directed.

1.3 QUALITY ASSURANCE

- A. In addition to requirements of these specifications, comply with manufacturer's instructions and recommendations for work.

1.4 PROTECTION

- A. All material shall be kept clean and protected from the weather.

1.5 SUBMITTALS

- A. Submit manufacturer's certificates indicating the meeting of all OSHA requirements.
- B. The Contractor shall furnish for approval complete shop drawings showing all framed work and all connections to concrete or masonry.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Aluminum, except as otherwise required, shall be aluminum alloy equivalent to specification 6063, rivets and screws shall be 2017 alloy, aluminum plate and structural shapes shall be 6061-T6 aluminum, and extruded shapes shall be 6063-T5, all as manufactured by the Aluminum Company of America; or approved equal.

2.2 FABRICATION

- A. Aluminum ladders shall be provided as shown on the Drawings and/or Specifications and shall meet OSHA requirements.
- B. Ladders shall be of aluminum alloy 6061-T6 or 6063- T5.

- C. All components of a ladder shall be designed for a minimum concentrated live load of 300 lbs.
- D. Ladders shall be welded assemblies, except as shown otherwise on the Drawings.
- E. All fasteners needed for mounting the ladders shall be Type 304 stainless steel.

2.3 PAINTING

- A. Direct contact between aluminum components and any dissimilar metals shall be prevented by painting the dissimilar metal with primer or asphalt paint.
- B. Direct contact between aluminum components and concrete or mortar shall be prevented by painting exposed aluminum surfaces with bituminous paint or water white methacrylate lacquer.
- C. Mechanical finishing shall be in accordance with NAAMM Finishes Manual. Electro-chemical, chemical, organic finishes on metal shall conform to industry standards.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. All work performed shall be in accordance with the manufacturer's recommendations for installation.
- B. All work shall be free from defects of any type which affect durability, strength, or appearance.
- C. Support brackets shall be securely anchored into the wall by anchor bolts or wedge type expansion bolts.

END OF SECTION 055100

SECTION 055116 – ALUMINUM FLOOR PLATES AND FRAMES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

1.2 DESCRIPTION OF WORK

- A. The Contractor, under this section, shall furnish and properly install all aluminum checkered cover plates and frames as shown on the Drawings or as directed.
- B. It is the intent of this Contract that the final installation shall be complete in all respects and the Contractor will be responsible for all minor details, whether or not shown on the Drawings or specifically included in these Specifications.

1.3 QUALITY ASSURANCE

- A. In addition to requirements of these specifications, comply with manufacturer's instructions and recommendations for work.

1.4 SUBMITTALS

- A. Product Data: Submit manufacturer's technical data including structural loading data and application instructions.
- B. The Contractor shall furnish for approval complete shop drawings showing all floor plates and frames, including all connections/anchorage to other work.

PART 2 - PRODUCTS

2.1 ALUMINUM CHECKERED COVER PLATES

- A. Aluminum checkered cover plates shall be raised pattern and 1/4-in. thick, unless otherwise indicated.
- B. Material for aluminum cover plates shall be aluminum alloy 6061-T6 in accordance with the latest ASTM Specification B221.
- C. Cover plates shall be furnished with a standard mill finish.
- D. The cover plates shall be designed for three times a normal load of 100 lbs./sq. ft. Maximum deflection under a 100 lbs./sq. ft. load shall not exceed 1/4-in. or 1/180th of the span, whichever is least. Stiffeners shall be supplied when necessary.
- E. Individual plates shall not exceed a total weight of 100 lbs., unless otherwise directed by the Engineer.

- F. Plates not requiring hinges shall be bolted in place and shall be made airtight with a neoprene gasket.
- G. Cover plate frames shall conform to details on the Drawings. Frames shall be shop welded with full strength welds and all exposed welds ground flush.
- H. In a case where frames would be large and bending could occur, field jointing shall be allowed using mechanical joints. All frames shall be adequately braced and strapped to wood blocking during shipment and installation to prevent damage.
- I. Required hinges shall be stainless steel butt hinges or piano hinges.
- J. Required lifting handle shall be aluminum alloy 6061-T6.
- K. All required fasteners shall be Type 304 stainless steel.

2.2 PAINTING

- A. Direct contact between aluminum components and any dissimilar metals shall be prevented by painting the dissimilar metal with primer or asphalt paint.
- B. Direct contact between aluminum components and concrete or mortar shall be prevented by painting aluminum contact surfaces with bituminous paint or water white methacrylate lacquer.
- C. Mechanical finishing shall be in accordance with NAAMM Finishes Manual. Electro-chemical, chemical, organic finishes on metal shall conform to industry standards.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. The cover plates shall be installed in the frames set in the concrete surface to support the cover plates. The cover plates shall be set flush with the surrounding surface.
- B. No plate shall rock when any part of it is stepped on.

END OF SECTION 055116

SECTION 055200 – ALUMINUM HANDRAILS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

1.2 DESCRIPTION OF WORK

- A. The Contractor, under this section, shall provide and install all aluminum handrailing as shown on the Drawings or as directed. Unless otherwise shown on the Drawings, all handrailing shall be aluminum.
- B. It is the intent of this Contract that the final installation shall be complete in all respects, and the Contractor will be responsible for all minor details, whether or not shown on the Drawings or specifically included in these Specifications.

1.3 QUALITY ASSURANCE

- A. In addition to requirements of these specifications, comply with manufacturer's instructions and recommendations for work.

1.4 SUBMITTALS

- A. Submit manufacturer's certificates indicating the meeting of all OSHA requirements.
- B. The Contractor shall furnish for approval complete shop drawings showing all handrails and all connections/anchors to concrete or masonry.
 - 1. Design: Design of handrail members, connections, and anchorages shall be performed by a Professional Engineer, registered in the state of the project, experienced in similar design, retained by the manufacturer. Submit handrail engineering calculations, sealed by the engineer responsible for the design.
 - 2. Design Loads: non concurrent, 50 PLF or 200 pounds concentrated load to be applied along the top rail in any direction.
- C. Samples for Initial Selection: For products involving selection of color, texture, or design, including mechanical finishes.
- D. Samples for Verification: For each type of exposed finish required.
 - 1. Sections of each distinctly different linear railing type, including handrails, top rails, posts, and balusters.
 - 2. Fittings and brackets.
 - 3. Assembled Sample of railing system, made from full-size components, including top rail, post, handrail, and infill. Sample need not be full height.
 - a. Show method of connecting members at intersections.

PART 2 - PRODUCTS

2.1 HANDRAILING

- A. Aluminum pipe rails and posts shall be 1-1/2 in. nominal diameter pipe made of alloy 6063-T6. Aluminum handrail shall be anodized. The color shall be selected by the Engineer. Railing components, fastenings, and complete structure shall meet all requirements of OSHA. All rails and posts shall be Schedule 40, unless noted otherwise..
- B. All handrails, unless otherwise shown on the Drawings, shall be as follows:
 - 1. All bottom mounted rails should be 3 ft.-6 in. high, measured from the floor to the top of the rail, with intermediate rail on the posts. Posts shall be placed at a maximum of 4 ft. and at each change in direction. Posts shall be attached to the top of the walkway or curb as shown on the Drawings. Posts into the walkway shall be provided with a floor flange to present a pleasing appearance.
 - 2. Bends, where called for, shall be shop formed and present pleasing appearance.
 - 3. The top surface of the top railing shall be smooth and shall not be interrupted by a projecting fitting.
 - 4. All openings in the railing shall be spanned with a 1/4 in. type 304 stainless steel chain with snap hook at one end and fixed to post at other end. Hooks and eyes shall be stainless steel.
 - 5. Toe plates conform to OSHA Standards. Toe plates shall not be pop-riveted to posts.
 - 6. Provide exterior railings that allow for thermal movements resulting from the following maximum change (range) in ambient and surface temperatures by preventing buckling, opening of joints, overstressing of components, failure of connections, and other detrimental effects. Base engineering calculation on surface temperatures of materials due to both solar and heat gain and nighttime-sky heat loss.
 - a. Temperature Change (Range): 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.

2.2 PAINTING

- A. Direct contact between aluminum components and any dissimilar metals shall be prevented by painting the dissimilar metal with primer or asphalt paint.
- B. Direct contact between aluminum components and concrete or mortar shall be prevented by painting exposed aluminum surfaces with bituminous paint or water white methacrylate lacquer.
- C. Mechanical finishing shall be in accordance with NAAMM Finishes Manual. Electro-chemical, chemical, organic finishes on metal shall conform to industry standards.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. All work performed shall be in accordance with the manufacturer's recommendation for installation.
- B. All work shall be free from defects of any type which affect durability, strength, or appearance.
- C. Support brackets shall be securely anchored into the wall by anchor bolts or wedge type expansion bolts.

- D. Posts shall be set in approved floor flanges attached to the floor or curb by stainless steel concrete anchor bolts in new concrete or holes bored into existing concrete and secured in the new sockets or holes. The boring of holes in existing concrete shall be included in this Item.
- E. All erection shall meet OSHA requirements and the manufacturer's recommendations.
- F. Upon completion of railing installation all work shall be cleaned to make it acceptable for final inspection.
- G. For protection from temperature induced stresses an expansion joint and gap shall be provided in every top rail on a maximum of 24 feet. Top rails only shall have expansion joints between the fixed points. Use 1/8-inch gap between bottom rail and each fitting.

END OF SECTION 055200

SECTION 055300 – ALUMINUM FLOOR GRATING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

1.2 DESCRIPTION OF WORK

- A. This section includes the furnishing and the installing of all aluminum floor gratings as shown on the Drawings and necessary to complete the work of this contract. Gratings include all clips, spacers, frames, supports, fasteners, and other incidental materials needed for a complete installation.
- B. Floor grating and frames shall be as detailed on Drawings.

1.3 QUALITY ASSURANCE

- A. In addition to requirements of these specifications, comply with manufacturer's instructions and recommendations for work.

1.4 SUBMITTALS

- A. Samples of each type of floor gratings proposed shall be submitted for approval prior to placement of purchase orders.
- B. Manufacturer's catalog data showing:
 - 1. Dimensions, spacing, and construction of grating.
 - 2. Design tables showings limits for span length and deflection under various uniform and concentrated loads.
 - 3. Materials of construction.
- C. Detail shop drawings showing:
 - 1. Dimensions of each grating.
 - 2. Sectional assembly.
 - 3. Location and identification mark.
 - 4. Size and type of supporting frames required.

PART 2 - PRODUCTS

2.1 ALUMINUM FLOOR GRATING

- A. Material for aluminum floor gratings shall be aluminum alloy 6061-T6 and 6063-T5 for structural supports and frames in accordance with the latest ASTM Specification B221.
- B. Gratings shall be furnished with a standard mill finish.
- C. Aluminum bar gratings shall be designed for a live load of 300 lbs./sq. ft., except that when located in a roadway it shall be designed to carry a truck rear axle load of 24,000 lbs. Maximum deflection under 100 lbs./sq. ft. load shall not exceed 1/4-in. or 1/180th of the span, whichever is least. Gratings shall be 1-1/2 in. deep with spacer bars spaced not more than 4 in. unless otherwise shown, specified or required.
- D. Banding of the ends of bearing bars and around openings through the panels shall be provided by 1/4-in. aluminum bars of the same depth as the panels.
- E. Grating shall be fabricated from field dimensions taken after facilities requiring passage through the gratings are in place.
- F. Individual grating panels shall not exceed a total weight of 125 lbs. unless otherwise shown or specified.
- G. Grating frames shall conform to details on the Drawings. Frames shall be shop welded with full strength welds and all exposed welds ground flush.
- H. In a case where frames would be large and bending could occur, field jointing shall be allowed using mechanical joints. All frames shall be adequately braced and strapped to wood blocking during shipment and installation to prevent damage.

2.2 PAINTING

- A. Direct contact between aluminum components and any dissimilar metals shall be prevented by painting the dissimilar metal with primer or asphalt paint.
- B. Direct contact between aluminum components and concrete or mortar shall be prevented by painting aluminum contact surfaces with bituminous paint or water white methacrylate lacquer.
- C. Provide mill finish as fabricated in accordance with NAAMM Finishes Manual.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. The gratings shall be installed in angle frames set in the floor or fastened thereto to support the gratings. The tops of the gratings shall be set flush with the surface of the floor in which it is installed. No panel shall rock when any part of it is stepped on.
- B. A maximum spacing of 1/4 in. shall be maintained between the grating and adjacent surfaces.
- C. Type 304 stainless steel fasteners shall be installed where indicated on the Drawings or required.

END OF SECTION 055300

SECTION 061000 - ROUGH CARPENTRY

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification Sections, apply to work of this section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Wood products.
 - 2. Wood-preservative-treated lumber.
 - 3. Dimension lumber framing.
 - 4. Miscellaneous lumber.
 - 5. Plywood backing panels.
- B. Related Requirements:
 - 1. Section 061600 "Sheathing" for sheathing, subflooring, and underlayment.

1.3 DEFINITIONS

- A. Boards or Strips: Lumber of less than 2 inches nominal size in least dimension.
- B. Dimension Lumber: Lumber of 2 inches nominal size or greater but less than 5 inches nominal size in least dimension.
- C. Lumber grading agencies, and abbreviations used to reference them, include the following:
 - 1. NeLMA: Northeastern Lumber Manufacturers' Association.
 - 2. NLGA: National Lumber Grades Authority.
 - 3. SPIB: The Southern Pine Inspection Bureau.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of process and factory-fabricated product. Indicate component materials and dimensions and include construction and application details.
 - 1. Include data for wood-preservative treatment from chemical treatment manufacturer and certification by treating plant that treated materials comply with requirements. Indicate type of preservative used and net amount of preservative retained.
 - 2. Include data for fire-retardant treatment from chemical treatment manufacturer and certification by treating plant that treated materials comply with requirements. Include physical properties of treated materials based on testing by a qualified independent testing agency.

3. For fire-retardant treatments, include physical properties of treated lumber both before and after exposure to elevated temperatures, based on testing by a qualified independent testing agency in accordance with ASTM D5664.
4. For products receiving a waterborne treatment, include statement that moisture content of treated materials was reduced to levels specified before shipment to Project site.

1.5 INFORMATIONAL SUBMITTALS

A. Material Certificates:

1. For dimension lumber specified to comply with minimum allowable unit stresses. Indicate species and grade selected for each use and design values approved by the ALSC Board of Review.
2. For preservative-treated wood products. Indicate type of preservative used and net amount of preservative retained.

1.6 DELIVERY, STORAGE, AND HANDLING

- ### A.
- Stack wood products flat with spacers beneath and between each bundle to provide air circulation. Protect wood products from weather by covering with waterproof sheeting, securely anchored. Provide for air circulation around stacks and under coverings.

PART 2 - PRODUCTS

2.1 WOOD PRODUCTS

- #### A. Lumber: Comply with DOC PS 20 and applicable rules of grading agencies indicated. If no grading agency is indicated, comply with the applicable rules of any rules-writing agency certified by the ALSC Board of Review. Grade lumber by an agency certified by the ALSC Board of Review to inspect and grade lumber under the rules indicated.
1. Factory mark each piece of lumber with grade stamp of grading agency.
 2. Where nominal sizes are indicated, provide actual sizes required by DOC PS 20 for moisture content specified. Where actual sizes are indicated, they are minimum dressed sizes for dry wood products.
 3. Dress lumber, S4S, unless otherwise indicated.
- #### B. Maximum Moisture Content:
1. Boards: 19 percent.
 2. Dimension Lumber: 19 percent unless otherwise indicated.

2.2 WOOD-PRESERVATIVE-TREATED LUMBER

- #### A. Preservative Treatment by Pressure Process: AWWA U1, Use categories as follows:
1. UC2: Interior construction not in contact with ground but may be subject to moisture. Include the following items:
 - a. Wood blocking, furring, stripping, and similar concealed members in

- D. Identify fire-retardant-treated wood with appropriate classification marking of qualified testing agency and other information required by authorities having jurisdiction.
- E. Application: Treat items indicated on Drawings, and the following:
 - 1. Concealed blocking.
 - 2. Plywood backing panels.

2.4 MISCELLANEOUS LUMBER

- A. Provide miscellaneous lumber indicated and lumber for support or attachment of other construction, including the following:
 - 1. Blocking.
 - 2. Nailers.
 - 3. Furring.
 - 4. Utility shelving.
- B. Dimension Lumber Items: Construction or No. 2 grade lumber of any of the following species:
 - 1. Hem-fir (north); NLGA.
 - 2. Mixed southern pine or southern pine; SPIB.
 - 3. Spruce-pine-fir; NLGA.
 - 4. Northern species; NLGA.
 - 5. Eastern softwoods; NeLMA.
- C. Utility Shelving: Lumber with 19 percent maximum moisture content of any of the following species and grades:
 - 1. Eastern white pine, Idaho white, lodgepole, ponderosa, or sugar pine; Premium or No. 2 Common (Sterling) grade; NeLMA, NLGA, WCLIB, or WWPA.
 - 2. Mixed southern pine or southern pine; No. [1] [2] grade; SPIB.
 - 3. Hem-fir or hem-fir (north); Construction or No. 2 Common grade; NLGA, WCLIB, or WWPA.
 - 4. Spruce-pine-fir (south) or spruce-pine-fir; Construction or No. 2 Common grade; NeLMA, NLGA, WCLIB, or WWPA.
- D. Concealed Boards: 19 percent maximum moisture content and any of the following species and grades:
 - 1. Mixed southern pine or southern pine; No. 2 grade; SPIB.
 - 2. Eastern softwoods; No. 2 Common grade; NeLMA.
 - 3. Northern species; No. 2 Common grade; NLGA.

2.5 PLYWOOD BACKING PANELS

- A. Equipment Backing Panels: Plywood, DOC PS 1, fire-retardant treated, in thickness indicated or, if not indicated, not less than 3/4-inch nominal thickness.

2.6 FASTENERS

- A. General: Fasteners are to be of size and type indicated and comply with requirements specified in this article for material and manufacture. Provide nails or screws, in sufficient length, to penetrate not less than 1-1/2 inches into wood substrate.
 - 1. Where rough carpentry is exposed to weather, in ground contact, pressure-preservative treated, or in area of high relative humidity, provide fasteners with hot-dip zinc coating complying with ASTM A153/A153M or ASTM F2329.
- B. Nails, Brads, and Staples: ASTM F1667.
- C. Power-Driven Fasteners: Fastener systems with an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES AC70.
- D. Post-Installed Anchors: Fastener systems with an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES AC01 or ICC-ES AC193 as appropriate for the substrate.

2.7 MISCELLANEOUS MATERIALS

- A. Sill-Sealer Gaskets:
 - 1. Closed-cell neoprene foam, 1/4 inch thick, selected from manufacturer's standard widths to suit width of sill members indicated.
- B. Flexible Flashing: Composite, self-adhesive, flashing product consisting of a pliable, butyl rubber or rubberized-asphalt compound, bonded to a high-density polyethylene film, aluminum foil, or spunbonded polyolefin to produce an overall thickness of not less than 0.025 inch.
- C. Adhesives for Gluing Furring and Sleepers to Concrete or Masonry: Formulation complying with ASTM D3498 that is approved for use indicated by adhesive manufacturer.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Framing Standard: Comply with AF&PA's WCD 1, "Details for Conventional Wood Frame Construction," unless otherwise indicated.
- B. Set work to required levels and lines, with members plumb, true to line, cut, and fitted. Fit rough carpentry accurately to other construction. Locate furring, nailers, blocking, and similar supports to comply with requirements for attaching other construction.
- C. Install plywood backing panels by fastening to studs; coordinate locations with utilities requiring backing panels. Install fire-retardant-treated plywood backing panels with classification marking of testing agency exposed to view.

- D. Install metal framing anchors to comply with manufacturer's written instructions. Install fasteners through each fastener hole.
- E. Do not splice structural members between supports unless otherwise indicated.
- F. Provide blocking and framing as indicated and as required to support facing materials, fixtures, specialty items, and trim.
 - 1. Provide metal clips for fastening gypsum board or lath at corners and intersections where framing or blocking does not provide a surface for fastening edges of panels. Space clips not more than 16 inches o.c.
- G. Sort and select lumber so that natural characteristics do not interfere with installation or with fastening other materials to lumber. Do not use materials with defects that interfere with function of member or pieces that are too small to use with minimum number of joints or optimum joint arrangement.
- H. Comply with AWPA M4 for applying field treatment to cut surfaces of preservative-treated lumber.
 - 1. Use inorganic boron for items that are continuously protected from liquid water.
 - 2. Use copper naphthenate for items not continuously protected from liquid water.
- I. Where wood-preservative-treated lumber is installed adjacent to metal decking, install continuous flexible flashing separator between wood and metal decking.
- J. Securely attach rough carpentry work to substrate by anchoring and fastening as indicated, complying with the following:
 - 1. Table 2304.10.1, "Fastening Schedule," in ICC's International Building Code (IBC).
- K. Securely attach roofing nailers to substrates by anchoring and fastening to withstand bending, shear, or other stresses imparted by Project wind loads and fastener-resistance loads as designed in accordance with ASCE/SEI 7.

3.2 INSTALLATION OF WOOD BLOCKING AND NAILERS

- A. Install where indicated and where required for attaching other work. Form to shapes indicated and cut as required for true line and level of attached work. Coordinate locations with other work involved.
- B. Attach wood blocking to substrates to support applied loading. Recess bolts and nuts flush with surfaces unless otherwise indicated.
- C. Install sill sealer gasket to form continuous seal between nailer plates and masonry walls.

3.3 INSTALLATION OF WOOD FURRING

- A. Install level and plumb with closure strips at edges and openings. Shim with wood as required for tolerance of finish work.

- B. Furring to Receive Gypsum Board or Plaster Lath: Install 1-by-2-inch nominal- size furring vertically at 16 inches o.c.

END OF SECTION 061000

SECTION 071416 - COLD FLUID-APPLIED WATERPROOFING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification Sections, apply to work of this section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Cold-applied rubberized asphalt waterproofing.
- B. Related Requirements:
 - 1. Section 072100 "Thermal Insulation" for below-grade foundation insulation.
 - 2. Section 079200 "Joint Sealants" for joint sealants, joint fillers, and joint preparation.

1.3 DEFINITIONS

- A. Compatible: Material that will not adversely affect adjacent materials, is chemically compatible with adjacent materials, and where required for bond, achieves adhesive compatibility with adjacent materials.
- B. Chemical Compatibility: Material that will not break down, deteriorate, degrade, or prematurely fail when in contact with another material. Material that will not cause chemical breakdown, deterioration, degradation, staining, or premature failure of another material.
- C. Adhesive Compatibility: Material that will develop bond strength or provide a suitable surface for another material to develop bond strength complying with requirements when in contact with another material.

1.4 COORDINATION

- A. Coordinate Work under this Section with adjacent concrete foundation work, including fill, other waterproofing systems, under-slab vapor retarders, under-slab insulation.
- B. Coordinate requirements for concrete formwork to provide suitable substrate for waterproofing and to minimize penetrations in waterproofing.

1.5 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include manufacturer's written instructions for evaluating, preparing, and treating substrate.

1.6 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer.
- B. Sample warranties.

1.7 QUALITY ASSURANCE

- A. Installer Qualifications: Entity that employs installers and supervisors who are trained and approved by waterproofing manufacturer.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Store materials in their original undamaged containers in a clean, dry, protected location and within the temperature range required by waterproofing manufacturer. Protect stored materials in accordance with manufacturer's written instructions.
- B. Remove and replace materials that cannot be applied within their stated shelf life.

1.9 FIELD CONDITIONS

- A. Environmental Limitations: Apply waterproofing within the range of ambient and substrate temperatures recommended in writing by waterproofing manufacturer.
- B. Maintain adequate ventilation during application and curing of waterproofing materials.

1.10 WARRANTY

- A. Manufacturer's Special Warranty: Manufacturer agrees to repair or remove and replace waterproofing that fails to remain watertight within specified warranty period.
 - 1. Warranty Period: 10 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

- A. Waterproofing System: Obtain waterproofing materials, protection course, and insulation drainage panels from same manufacturer as waterproofing membrane, or manufacturer approved by waterproofing membrane manufacturer.

2.2 POLYURETHANE WATERPROOFING

- A. Single-Component, Reinforced, Modified Polyurethane Waterproofing: ASTM C836/C836M, and coal-tar free.
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

- a. Barrett Company
- b. Carlisle Coatings & Waterproofing Inc
- c. Liquid Plastics Inc.
- d. Master Builders Solutions; brand of MBCC Group
- e. Polycoat Products
- f. Sika Corporation

2.3 ACCESSORY WATERPROOFING SYSTEM MATERIALS

- A. General: Accessory materials as recommended in writing by waterproofing manufacturer for intended use and compatible with one another and with waterproofing.
- B. Primer: Liquid waterborne primer as recommended in writing for substrate by waterproofing manufacturer.
- C. Surface Conditioner: Liquid, waterborne surface conditioner as recommended in writing for substrate by waterproofing manufacturer.
- D. Sheet Flashing: Manufacturer's standard flashing sheet.
 - 1. Adhesive: Manufacturer's standard contact adhesive.
- E. Reinforcing Fabric: Manufacturer's standard fiberglass mesh or spun-bonded polyester fabric.
- F. Detailing Seam Tape: Manufacturer's standard detailing tape.
- G. Joint Sealant: Single-component polyurethane sealant, compatible with waterproofing; ASTM C920, Type M, Class 25 or greater; Grade NS for sloping and vertical applications and Grade P for deck applications; Use NT exposure; and as recommended in writing by waterproofing manufacturer for substrate and joint conditions.
- H. Backer Rod: Closed-cell polyethylene foam.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements and other conditions affecting performance of the Work.
 - 1. Verify that concrete has cured and aged for minimum time period as recommended in writing by waterproofing manufacturer.
 - 2. Verify that substrate is visibly dry and within the moisture limits as recommended in writing by waterproofing manufacturer. Test for capillary moisture by plastic sheet method in accordance with ASTM D4263.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Clean, prepare, and treat substrates in accordance with waterproofing manufacturer's written instructions. Provide clean, dust-free, and dry substrates for waterproofing application.
- B. Mask off adjoining surfaces not receiving waterproofing to prevent spillage and overspray affecting other construction.
- C. Close off deck drains and other deck penetrations to prevent spillage and migration of waterproofing fluids.
- D. Remove grease, oil, bitumen, form-release agents, paints, curing compounds, acid residues, and other penetrating contaminants or film-forming coatings from concrete.
- E. Remove fins, ridges, and other projections, and fill honeycomb, aggregate pockets, holes, and other voids.

3.3 PREPARATION AT TERMINATIONS, PENETRATIONS, AND CORNERS

- A. Prepare surfaces at terminations and penetrations through waterproofing and at expansion joints, drains, sleeves, and corners in accordance with waterproofing manufacturer's written instructions and to recommendations in ASTM C1471/C1471M.

3.4 TREATMENT OF JOINTS AND CRACKS

- A. Prepare, treat, rout, and fill joints and cracks in substrate in accordance with waterproofing manufacturer's written instructions and to recommendations in ASTM C1471/C1471M. Before coating surfaces, remove dust and dirt from joints and cracks in accordance with ASTM D4258.
 - 1. Comply with ASTM C1193 for joint-sealant installation.
 - 2. Apply bond breaker on sealant surface, beneath preparation strip.
 - 3. Prime substrate along each side of joint and apply a single thickness of preparation strip at least 6 inches wide along each side of joint. Apply waterproofing in two separate applications and embed a joint-reinforcing strip in first preparation coat.

3.5 INSTALLATION OF WATERPROOFING

- A. General: Apply waterproofing in accordance with manufacturer's written instructions and to recommendations in ASTM C1471/C1471M.
- B. Start installing waterproofing in presence of manufacturer's technical representative.
- C. Apply primer over prepared substrate at manufacturer's recommended rate and allow it to dry.
- D. Reinforced Waterproofing Membrane Applications: Mix materials and apply waterproofing by roller, notched squeegee, trowel, or other suitable application method.

1. Apply first coat of waterproofing, embed membrane-reinforcing fabric, and apply second coat of waterproofing to completely saturate reinforcing fabric and to obtain a seamless reinforced membrane free of entrapped gases and pinholes, with an average dry film total thickness of 70 mils.
 2. Apply reinforced waterproofing to prepared wall terminations and vertical surfaces.
 3. Verify manufacturer's recommended wet film thickness of waterproofing every 100 sq. ft.
- E. Cure waterproofing, taking care to prevent contamination and damage to membrane.

3.6 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a site representative qualified by waterproofing system manufacturer to inspect substrate conditions, surface preparation, membrane application, flashings, protection, and drainage components and to furnish daily reports to A/E.
1. Final Inspection: Arrange for waterproofing system manufacturer's technical personnel to inspect system installation on completion, in presence of A/E, and to prepare inspection report.
 2. Repair or remove and replace components of waterproofing system where inspections indicate that they do not comply with specified requirements.
- B. Additional Tests and Inspections:
1. Additional testing and inspecting, at Contractor's expense, will be performed to determine if replaced or additional work complies with specified requirements.
 2. Waterproofing system will be considered defective if it does not pass tests and inspections.
- C. Prepare test and inspection reports.

3.7 PROTECTION AND CLEANING

- A. Protect waterproofing system from damage and wear during remainder of construction period.
- B. Correct deficiencies in or remove waterproofing system that does not comply with requirements, repair substrates, and repair or reinstall waterproofing system to a condition free of damage and deterioration at time of Substantial Completion and in accordance with warranty requirements.
- C. Clean spillage and soiling from adjacent construction using cleaning agents and procedures recommended in writing by manufacturer of affected construction.

END OF SECTION 071416

SECTION 072100 - THERMAL INSULATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification Sections, apply to work of this section.

1.2 SUMMARY

- A. Section Includes:

- 1. Extruded polystyrene foam-plastic board insulation.

- B. Related Requirements:

- 1. Section 042000 "Unit Masonry" for insulation installed in masonry cells.
 - 2. Section 075323 "Ethylene-Propylene-Diene-Monomer (EPDM) Roofing" for insulation specified as part of roofing construction.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.

1.4 INFORMATIONAL SUBMITTALS

- A. Installer's Certification: Listing type, manufacturer, and R-value of insulation installed in each element of the building thermal envelope.

- 1. For blown-in or sprayed fiberglass and cellulosic-fiber loose-fill insulation, indicate initial installed thickness, settled thickness, settled R-value, installed density, coverage area, and number of bags installed.
 - 2. Sign, date, and post the certification in a conspicuous location on Project site.

- B. Product Test Reports: For each product, for tests performed by a qualified testing agency.

- C. Research Reports: For foam-plastic insulation, from ICC-ES.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Protect insulation materials from physical damage and from deterioration due to moisture, soiling, and other sources. Store inside and in a dry location. Comply with manufacturer's written instructions for handling, storing, and protecting during installation.

- B. Protect foam-plastic board insulation as follows:

- 1. Do not expose to sunlight except to necessary extent for period of installation and

- concealment.
- 2. Protect against ignition at all times. Do not deliver foam-plastic board materials to Project site until just before installation time.
- 3. Quickly complete installation and concealment of foam-plastic board insulation in each area of construction.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Surface-Burning Characteristics: Maximum flame-spread and smoke-developed indexes less than Class A, 25 and 450, Class B, 75 and 450 when tested in accordance with ASTM E84.
- B. Thermal-Resistance Value (R-Value): R-value as indicated on Drawings in accordance with ASTM C518.

2.2 EXTRUDED POLYSTYRENE FOAM-PLASTIC BOARD INSULATION (XPS)

- A. Extruded Polystyrene Board Insulation, Type IV: ASTM C578, Type IV, 25 psi minimum compressive strength; unfaced.
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. DiversiFoam Products
 - b. DuPont de Nemours, Inc.
 - c. Kingspan Insulation LLC
 - d. Owens Corning
 - e. The Dow Chemical Company

2.3 INSULATION FASTENERS

- A. Insulation Fastener Accessories: Provide double-pointed weld pins, lagging pins, quilting pins, duct liner pins, insulation hangers, specialty washers, special caps, j-hooks, capacitor discharge annular weld pins, capacitor discharge acoustical lagging pins, and other accessory materials that are recommended in writing by insulation fastener manufacturer to produce complete insulation supports.

2.4 ACCESSORIES

- A. Insulation for Miscellaneous Voids:
 - 1. Spray Polyurethane Foam Insulation: ASTM C1029, Type II, closed cell, with maximum flame-spread and smoke-developed indexes of 75 and 450, respectively, per ASTM E84.
- B. Miscellaneous Application Accessories:

1. Adhesive for Bonding Insulation: Product compatible with insulation and air and water barrier materials, and with demonstrated capability to bond insulation securely to substrates without damaging insulation and substrates.
2. Crack Sealer: Closed-cell insulating foam in aerosol dispenser recommended in writing by insulation manufacturer for filling gaps in board insulation.
3. Detailing Foam Insulation for Voids: Urethane foam complying with AAMA 812, low expansion pressure suitable for filling insulation gaps and voids adjacent to openings to protect against water, air, and sound intrusion.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Clean substrates of substances that are harmful to insulation, including removing projections capable of puncturing insulation or vapor retarders, or those that interfere with insulation attachment.

3.2 INSTALLATION, GENERAL

- A. Comply with insulation manufacturer's written instructions applicable to products, applications and applicable codes.
- B. Install insulation that is undamaged, dry, and unsoiled and that has not been left exposed to ice, rain, or snow at any time.
- C. Extend insulation to envelop entire area to be insulated. Fit tightly around obstructions and fill voids with insulation. Remove projections that interfere with placement.
- D. Provide sizes to fit applications and selected from manufacturer's standard thicknesses, widths, and lengths. Apply single layer of insulation units unless multiple layers are otherwise shown or required to make up total thickness or to achieve R-value.

3.3 INSTALLATION OF SLAB INSULATION

- A. On vertical slab edge and foundation surfaces, set insulation units using manufacturer's recommended adhesive in accordance with manufacturer's written instructions.
 1. If not otherwise indicated, extend insulation a minimum of 24 inches below exterior grade line.
- B. On horizontal surfaces, loosely lay insulation units in accordance with manufacturer's written instructions. Stagger end joints and tightly abut insulation units.
 1. If not otherwise indicated, extend insulation a minimum of 24 inches in from exterior walls.

3.4 INSTALLATION OF FOUNDATION WALL INSULATION

- A. Butt panels together for tight fit.

- B. Adhesive Installation: Install with adhesive or press into tacky waterproofing or damp-proofing in accordance with manufacturer's written instructions.

3.5 INSTALLATION OF CAVITY-WALL INSULATION

- A. Foam-Plastic Board Insulation: Install pads of adhesive spaced approximately 24 inches o.c. both ways on inside face and as recommended in writing by manufacturer.
 - 1. Fit courses of insulation between wall ties and other obstructions, with edges butted tightly in both directions, and with faces flush.
 - 2. Press units firmly against inside substrates.
 - 3. Supplement adhesive attachment of insulation by securing boards with two-piece wall ties designed for this purpose and specified in Section 042000 "Unit Masonry."

3.6 INSTALLATION OF BOARD INSULATION

- A. Install board insulation in accordance with manufacturer's written instructions per project applications and conditions.

3.7 PROTECTION

- A. Protect installed insulation from damage due to harmful weather exposures, physical abuse, and other causes.
- B. Provide temporary coverings or enclosures where insulation is subject to abuse and cannot be concealed and protected by permanent construction immediately after installation.

END OF SECTION 072100

SECTION 072500 - WEATHER BARRIERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification Sections, apply to work of this section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Building paper.

1.3 ACTION SUBMITTALS

- A. Product Data:
 - 1. For each type of product.

1.4 QUALITY ASSURANCE

- A. Installer Qualifications: A qualified firm that is approved, authorized, certified, or licensed by the weather barrier system manufacturer to install manufacturer's product and that is eligible to receive manufacturer's warranty.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Deliver roofing materials to Project site in original containers with seals unbroken and labeled with manufacturer's name, product brand name and type, date of manufacture, approval or listing agency markings, and directions for storing and mixing with other components.

1.6 FIELD CONDITIONS

- A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit roofing system to be installed in accordance with manufacturer's written installation instructions and warranty requirements.

PART 2 - PRODUCTS

2.1 ACCESSORY MATERIALS

- A. Requirement: Provide primers, fasteners, seam tapes, flashing, transition strips, termination strips, joint sealants, counterflashing strips, flashing sheets and metal termination bars, termination mastic, substrate patching materials, adhesives, tapes, foam sealants, lap sealants, and other accessory materials that are recommended in

writing by weather barrier manufacturer to produce a complete weather barrier assembly and that are compatible with primary weather barrier material and adjacent construction to which they may seal.

PART 3 - EXECUTION

3.1 INSTALLATION OF WEATHER BARRIERS

A. Weather Barriers:

1. Building Paper: Comply with manufacturer's written instructions and warranty requirements.

B. Install weather barrier accessories for a complete installation with weather barriers in accordance with manufacturers written instructions.

END OF SECTION 072500

SECTION 072726 - FLUID-APPLIED MEMBRANE AIR BARRIERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification Sections, apply to work of this section.

1.2 SUMMARY

- A. Section Includes:

- 1. Medium-build air barriers, vapor retarding.

- B. Related Requirements:

- 1. Section 061600 "Sheathing" for wall sheathings and wall sheathing joint-and-penetration treatments.
 - 2. Section 072500 "Weather Barriers" for weather barriers, including building paper.

1.3 ACTION SUBMITTALS

- A. Product Data: Include manufacturer's written instructions for evaluating, preparing, and treating each substrate; technical data; dry film thickness; and tested physical and performance properties of products.

- 1. Medium-build air barriers, vapor retarding.

1.4 INFORMATIONAL SUBMITTALS

- A. Product Certificates: From air-barrier manufacturer, certifying compatibility of air barriers and accessory materials with Project materials that connect to or that come in contact with the barrier.

- B. Product Test Reports: For each air-barrier assembly, for tests performed by a qualified testing agency.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Remove and replace liquid materials that cannot be applied within their stated shelf life.
- B. Protect stored materials from direct sunlight.

1.7 FIELD CONDITIONS

- A. Environmental Limitations: Apply air barrier within the range of ambient and substrate temperatures recommended in writing by air-barrier manufacturer.
 - 1. Protect substrates from environmental conditions that affect air-barrier performance.
 - 2. Do not apply air barrier to a damp or wet substrate or during snow, rain, fog, or mist.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

- A. Obtain primary air-barrier materials and air-barrier accessories from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

- A. Air-Barrier Performance: Air-barrier assembly and seals with adjacent construction to be capable of performing as a continuous air barrier and as a liquid-water drainage plane flashed to discharge to the exterior incidental condensation or water penetration. Air-barrier assemblies to be capable of accommodating substrate movement and of sealing substrate expansion and control joints, construction material changes, penetrations, tie-ins to installed waterproofing, and transitions at perimeter conditions without deterioration and air leakage exceeding specified limits.
- B. Air-Barrier Assembly Air Leakage: Maximum 0.04 cfm/sq. ft. of surface area at 1.57 lbf/sq. ft., when tested in accordance with ASTM E2357.
- C. Air Permeance: Maximum 0.004 cfm/sq. ft. of surface area at 1.57 lbf/sq. ft pressure difference; ASTM E2178.
- D. Ultimate Elongation: Minimum 250 percent; ASTM D412, Die C.
- E. Adhesion to Substrate: Minimum 16 lbf/sq. in. when tested in accordance with ASTM D4541.
- F. UV Resistance: Can be exposed to sunlight for 30 days in accordance with manufacturer's written instructions.

2.3 ACCESSORY MATERIALS

- A. Provide primers, transition strips, termination strips, joint reinforcing fabric and strips, joint sealants, counterflashing strips, flashing sheets and metal termination bars, termination mastic, substrate patching materials, adhesives, tapes, foam sealants, lap sealants, and other accessory materials that are recommended in writing by air-barrier manufacturer to produce a complete air-barrier assembly and that are compatible with primary air-barrier material and adjacent construction to which they may seal.

- B. Primer: Liquid primer recommended for substrate by air-barrier material manufacturer.
- C. Stainless Steel Sheet: ASTM A240/A240M, Type 304, 0.0187 inch thick, and Series 300 stainless steel fasteners.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements and other conditions affecting performance of the Work.
 - 1. Verify that substrates are sound and free of oil, grease, dirt, excess mortar, or other contaminants.
 - 2. Verify that substrates have cured and aged for minimum time recommended in writing by air-barrier manufacturer.
 - 3. Verify that substrates are visibly dry and free of moisture. Test concrete substrates for capillary moisture by plastic sheet method in accordance with ASTM D4263.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 SURFACE PREPARATION

- A. Clean, prepare, treat, fill, and seal substrate and joints and cracks in substrate in accordance with manufacturer's written instructions and details. Provide clean, dust-free, and dry substrate for air-barrier application.
- B. Mask off adjoining surfaces not covered by air barrier to prevent spillage and overspray affecting other construction.
- C. Remove grease, oil, bitumen, form-release agents, paints, curing compounds, and other penetrating contaminants or film-forming coatings from concrete.
- D. Remove fins, ridges, mortar, and other projections and fill honeycomb, aggregate pockets, holes, and other voids in concrete with substrate-patching material.
- E. Remove excess mortar from masonry ties, shelf angles, and other obstructions.
- F. At changes in substrate plane, apply sealant or termination mastic beads at sharp corners and edges to form a smooth transition from one plane to another.
- G. Cover gaps in substrate plane and form a smooth transition from one substrate plane to another with stainless steel sheet mechanically fastened to structural framing to provide continuous support for air barrier.
- H. Bridge isolation joints and discontinuous wall-to-wall, deck-to-wall, and deck-to-deck joints with air-barrier accessory material that accommodates joint movement in accordance with manufacturer's written instructions and details.

3.3 INSTALLATION OF ACCESSORIES

- A. Install accessory materials in accordance with air-barrier manufacturer's written instructions and details to form a seal with adjacent construction and ensure continuity of air and water barrier.
 - 1. Coordinate the installation of air barrier with installation of roofing membrane and base flashing to ensure continuity of air barrier with roofing membrane.
 - 2. Install transition strip on roofing membrane or base flashing so that a minimum of 3 inches of coverage is achieved over each substrate.
 - 3. Unless manufacturer recommends in writing against priming, apply primer to substrates at required rate and allow it to dry.
 - 4. Apply primer to substrates at required rate and allow it to dry. Limit priming to areas that will be covered by air-barrier material on same day. Reprime areas exposed for more than 24 hours.
- B. Connect and seal exterior wall air-barrier material continuously to roofing-membrane air barrier, concrete below-grade structures, floor-to-floor construction, exterior glazing and window systems, glazed curtain-wall systems, storefront systems, exterior louvers, exterior door framing, and other construction used in exterior wall openings, using accessory materials.
- C. At end of each working day, seal top edge of strips and transition strips to substrate with termination mastic.
- D. Apply joint sealants forming part of air-barrier assembly within manufacturer's recommended application temperature ranges. Consult manufacturer when sealant cannot be applied within these temperature ranges.
- E. Wall Openings: Prime concealed, perimeter frame surfaces of windows, curtain walls, storefronts, and doors. Apply transition strip so that a minimum of 3 inches of coverage is achieved over each substrate. Maintain 3 inches of full contact over firm bearing to perimeter frames, with not less than 1 inch of full contact.
 - 1. Transition Strip: Roll firmly to enhance adhesion.
- F. Fill gaps in perimeter frame surfaces of windows, curtain walls, storefronts, and doors, and miscellaneous penetrations of air-barrier material with foam sealant.
- G. Seal top of through-wall flashings to air barrier with an additional 6-inch- wide, transition strip.
- H. Seal exposed edges of strips at seams, cuts, penetrations, and terminations not concealed by metal counterflashings or ending in reglets with termination mastic.
- I. Repair punctures, voids, and deficient lapped seams in strips and transition strips. Slit and flatten fishmouths and blisters. Patch with transition strips extending 6 inches beyond repaired areas in strip direction.

3.4 INSTALLATION OF PRIMARY AIR-BARRIER MATERIAL

- A. Apply air-barrier material to form a seal with strips and transition strips and to achieve a continuous air barrier in accordance with air-barrier manufacturer's written instructions and details. Apply air-barrier material within manufacturer's recommended application temperature ranges.
 - 1. Unless manufacturer recommends in writing against priming, apply primer to substrates at required rate and allow it to dry.
 - 2. Limit priming to areas that will be covered by air-barrier material on same day. Reprime areas exposed for more than 24 hours.
 - 3. Where multiple prime coats are needed to achieve required bond, allow adequate drying time between coats.
- B. Medium-Build Air Barriers: Apply continuous unbroken air-barrier material to substrates according to the following thickness. Apply an increased thickness of air-barrier material in full contact around protrusions such as masonry ties.
 - 1. Vapor-Retarding, Medium-Build Air Barrier: Total dry film thickness as recommended in writing by manufacturer to comply with performance requirements, applied in one or more equal coats. Apply additional material as needed to achieve void- and pinhole-free surface.
- C. Do not cover air barrier until it has been tested and inspected by testing agency.
- D. Correct deficiencies in or remove air barrier that does not comply with requirements; repair substrates and reapply air-barrier components.

3.5 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Air barriers will be considered defective if they do not pass tests and inspections.
 - 1. Apply additional air-barrier material, in accordance with manufacturer's written instructions, where inspection results indicate insufficient thickness.
 - 2. Remove and replace deficient air-barrier components for retesting as specified above.
- C. Repair damage to air barriers caused by testing; follow manufacturer's written instructions.
- D. Prepare test and inspection reports.

3.6 CLEANING AND PROTECTION

- A. Protect air-barrier system from damage during application and remainder of construction period, in accordance with manufacturer's written instructions.
 - 1. Protect air barrier from exposure to UV light and harmful weather exposure as

recommended in writing by manufacturer. If exposed to these conditions for longer than recommended, remove and replace air barrier or install additional, full-thickness, air-barrier application after repairing and preparing the overexposed materials in accordance with air-barrier manufacturer's written instructions.

2. Protect air barrier from contact with incompatible materials and sealants not approved by air-barrier manufacturer.
- B. Clean spills, stains, and soiling from construction that would be exposed in the completed work using cleaning agents and procedures recommended in writing by manufacturer of affected construction.
 - C. Remove masking materials after installation.

END OF SECTION 072726

SECTION 074113.16 - STANDING-SEAM METAL ROOF PANELS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Standing-seam metal roof panels.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Samples: For each type of metal panel indicated.

1.3 INFORMATIONAL SUBMITTALS

- A. Product test reports.
- B. Warranties: Sample of special warranties.

1.4 CLOSEOUT SUBMITTALS

- A. Maintenance data.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer.
- B. UL-Certified, Portable Roll-Forming Equipment: UL-certified, portable roll-forming equipment capable of producing metal panels warranted by manufacturer to be the same as factory-formed products. Maintain UL certification of portable roll-forming equipment for duration of work.

1.6 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of metal panel systems that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period: Two years from date of Substantial Completion.
- B. Special Warranty on Panel Finishes: Manufacturer's standard form in which manufacturer agrees to repair finish or replace metal panels that show evidence of deterioration of factory-applied finishes within specified warranty period.
 - 1. Finish Warranty Period: 20 years from date of Substantial Completion.

- C. Special Weathertightness Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace standing-seam metal roof panel assemblies that fail to remain weathertight, including leaks, within specified warranty period.
 - 1. Warranty Period: 20 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Solar Reflectance Index (SRI): Three-year-aged SRI not less than 64 when calculated according to ASTM E 1980, based on testing identical products by a qualified testing agency.
- B. Structural Performance: Provide metal panel systems capable of withstanding the effects of the following loads, based on testing according to ASTM E1592:
 - 1. Wind Loads: As indicated on Drawings.
 - 2. Other Design Loads: As indicated on Drawings.
 - 3. Deflection Limits: For wind loads, no greater than 1/240 of the span.
- C. Air Infiltration: Air leakage of not more than 0.06 cfm/sq. ft. when tested according to ASTM E1680 at the following test-pressure difference:
 - 1. Test-Pressure Difference: 6.24 lbf/sq. ft.
- D. Water Penetration under Static Pressure: No water penetration when tested according to ASTM E1646 at the following test-pressure difference:
 - 1. Test-Pressure Difference: 6.24 lbf/sq. ft.
- E. Wind-Uplift Resistance: Provide metal roof panel assemblies that comply with UL 580 for wind-uplift-resistance class indicated.
 - 1. Uplift Rating: UL 90.
- F. FM Global Listing: Provide metal roof panels and component materials that comply with requirements in FM Global 4471 as part of a panel roofing system and that are listed in FM Global's "Approval Guide" for Class 1 or noncombustible construction, as applicable. Identify materials with FM Global markings.
 - 1. Fire/Windstorm Classification: Class 1A- 90.
 - 2. Hail Resistance: SH.
- G. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes by preventing buckling, opening of joints, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects. Base calculations on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.
 - 1. Temperature Change (Range): 120 deg F, ambient; 180 deg F, material surfaces.

2.2 STANDING-SEAM METAL ROOF PANELS

- A. Provide factory-formed metal roof panels designed to be installed by lapping and interconnecting raised side edges of adjacent panels with joint type indicated and mechanically attaching panels to supports using concealed clips in side laps. Include clips, cleats, pressure plates, and accessories required for weathertight installation.
 - 1. Steel Panel Systems: Unless more stringent requirements are indicated, comply with ASTM E1514.
 - 2. Aluminum Panel Systems: Unless more stringent requirements are indicated, comply with ASTM E1637.

- B. Vertical-Rib, Snap-Joint, Standing-Seam Metal Roof Panels: Formed with vertical ribs at panel edges and intermediate stiffening ribs symmetrically spaced between ribs; designed for sequential installation by mechanically attaching panels to supports using concealed clips located under one side of panels, engaging opposite edge of adjacent panels, and snapping panels together.
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. ATAS International, Inc.
 - b. Berridge Manufacturing Company.
 - c. CENTRIA, a Nucor Brand.
 - d. Custom-Bilt Metals Inc.
 - e. Dimensional Metals, Inc.
 - f. Drexel Metals.
 - g. Englert, Inc.
 - h. Everlast Metals.
 - i. Garland Company, Inc. (The).
 - j. MBCI; Cornerstone Building Brands.
 - k. McElroy Metal, Inc.
 - l. PAC-CLAD; Petersen Aluminum Corporation; a Carlisle company.
 - m. Ultra Seam, Inc.
 - 2. Metallic-Coated Steel Sheet: Zinc-coated (galvanized) steel sheet complying with ASTM A653/A653M, G90 coating designation, or aluminum-zinc alloy-coated steel sheet complying with ASTM A792/A792M, Class AZ50 coating designation; structural quality. Prepainted by the coil-coating process to comply with ASTM A755/A755M.
 - a. Nominal Thickness: 0.028 inch.
 - b. Exterior Finish: Three-coat fluoropolymer.
 - c. Color: As selected by A/E from manufacturer's full range.
 - 3. Clips: Two-piece floating to accommodate thermal movement.
 - 4. Material:
 - a. 0.028-inch- nominal thickness, zinc-coated (galvanized) or aluminum-zinc alloy-coated steel sheet.
 - b. 0.025-inch- thick, stainless-steel sheet.
 - 5. Panel Coverage: 24 inches.
 - 6. Panel Height: 1.75 inches.

2.3 UNDERLAYMENT MATERIALS

- A. Self-Adhering, High-Temperature Underlayment: Provide self-adhering, cold-applied, sheet underlayment, a minimum of 30 mils thick, consisting of slip-resistant, polyethylene-film top surface laminated to a layer of butyl or SBS-modified asphalt adhesive, with release-paper backing. Provide primer when recommended by underlayment manufacturer.
 - 1. Thermal Stability: Stable after testing at 240 deg F; ASTM D1970.
 - 2. Low-Temperature Flexibility: Passes after testing at minus 20 deg F; ASTM D1970.
 - 3. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. ATAS International, Inc.
 - b. Carlisle WIP Products; a brand of Carlisle Construction Materials.
 - c. GCP Applied Technologies Inc.
 - d. Henry Company; a Carlisle company.
 - e. Owens Corning.
 - f. Polyglass U.S.A., Inc.
 - g. Protecto Wrap Company.
 - h. SDP Advanced Polymer Products Inc.
- B. Felt Underlayment: ASTM D226/D226M, Type II (No. 30), asphalt-saturated organic felts.
- C. Slip Sheet: Manufacturer's recommended slip sheet, of type required for application.

2.4 MISCELLANEOUS MATERIALS

- A. Miscellaneous Metal Subframing and Furring: ASTM C645; cold-formed, metallic-coated steel sheet, ASTM A653/A653M, G90 hot-dip galvanized coating designation or ASTM A792/A792M, Class AZ50 coating designation unless otherwise indicated. Provide manufacturer's standard sections as required for support and alignment of metal panel system.
- B. Panel Accessories: Provide components required for a complete, weathertight panel system including trim, copings, fasciae, mullions, sills, corner units, clips, flashings, sealants, gaskets, fillers, closure strips, and similar items. Match material and finish of metal panels unless otherwise indicated.
 - 1. Closures: Provide closures at eaves and ridges, fabricated of same metal as metal panels.
 - 2. Closure Strips: Closed-cell, expanded, cellular, rubber or crosslinked, polyolefin-foam or closed-cell laminated polyethylene; minimum 1-inch- thick, flexible closure strips; cut or premolded to match metal panel profile. Provide closure strips where indicated or necessary to ensure weathertight construction.
- C. Flashing and Trim: Provide flashing and trim formed from same material as metal panels as required to seal against weather and to provide finished appearance. Locations include, but are not limited to, eaves, rakes, corners, bases, framed openings, ridges,

fasciae, and fillers. Finish flashing and trim with same finish system as adjacent metal panels.

- D. Gutters and Downspouts: Formed from same material as roof panels according to SMACNA's "Architectural Sheet Metal Manual." Finish to match roof fascia and rake trim.
- E. Panel Fasteners: Self-tapping screws designed to withstand design loads.
- F. Panel Sealants: Provide sealant type recommended by manufacturer that are compatible with panel materials, are nonstaining, and do not damage panel finish.
 - 1. Sealant Tape: Pressure-sensitive, 100 percent solids, gray polyisobutylene compound sealant tape with release-paper backing; 1/2 inch wide and 1/8 inch thick.
 - 2. Joint Sealant: ASTM C920; as recommended in writing by metal panel manufacturer.
 - 3. Butyl-Rubber-Based, Solvent-Release Sealant: ASTM C1311.

2.5 FABRICATION

- A. Fabricate and finish metal panels and accessories at the factory, by manufacturer's standard procedures and processes, as necessary to fulfill indicated performance requirements demonstrated by laboratory testing. Comply with indicated profiles and with dimensional and structural requirements.
- B. On-Site Fabrication: Subject to compliance with requirements of this Section, metal panels may be fabricated on-site using UL-certified, portable roll-forming equipment if panels are of same profile and warranted by manufacturer to be equal to factory-formed panels. Fabricate according to equipment manufacturer's written instructions and to comply with details shown.
- C. Provide panel profile, including major ribs and intermediate stiffening ribs, if any, for full length of panel.
- D. Fabricate metal panel joints with factory-installed captive gaskets or separator strips that provide a weathertight seal and prevent metal-to-metal contact, and that minimize noise from movements.
- E. Sheet Metal Flashing and Trim: Fabricate flashing and trim to comply with manufacturer's recommendations and recommendations in SMACNA's "Architectural Sheet Metal Manual" that apply to design, dimensions, metal, and other characteristics of item indicated.

2.6 FINISHES

- A. Panels and Accessories:
 - 1. Two-Coat Fluoropolymer: AAMA 621. Fluoropolymer finish containing not less than 70 percent polyvinylidene fluoride (PVDF) resin by weight in color coat.
 - 2. Concealed Finish: White or light-colored acrylic or polyester backer finish.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Miscellaneous Supports: Install subframing, furring, and other miscellaneous panel support members and anchorages according to ASTM C754 and metal panel manufacturer's written recommendations.

3.2 INSTALLATION OF UNDERLAYMENT

- A. Self-Adhering Sheet Underlayment: Apply primer if required by manufacturer. Comply with temperature restrictions of underlayment manufacturer for installation. Apply at locations indicated below, wrinkle free, in shingle fashion to shed water, and with end laps of not less than 6 inches staggered 24 inches between courses. Overlap side edges not less than 3-1/2 inches. Extend underlayment into gutter trough. Roll laps with roller. Cover underlayment within 14 days.
 - 1. Apply over the entire roof surface.
 - 2. Apply over the roof area indicated below:
 - a. Roof perimeter for a distance up from eaves of 36 inches beyond interior wall line.
 - b. Valleys, from lowest point to highest point, for a distance on each side of 18 inches. Overlap ends of sheets not less than 6 inches.
 - c. Rake edges for a distance of 18 inches.
 - d. Hips and ridges for a distance on each side of 12 inches.
 - e. Roof-to-wall intersections for a distance from wall of 18 inches.
 - f. Around dormers, chimneys, skylights, and other penetrating elements for a distance from element of 18 inches.
- B. Felt Underlayment: Apply at locations indicated below, in shingle fashion to shed water, and with lapped joints of not less than 2 inches.
 - 1. Apply over the entire roof surface.
 - 2. Apply on roof not covered by self-adhering sheet underlayment. Lap over edges of self-adhering sheet underlayment not less than 3 inches, in shingle fashion to shed water.
- C. Slip Sheet: Apply slip sheet over underlayment before installing metal roof panels.
- D. Flashings: Install flashings to cover underlayment to comply with requirements specified in Section 076200 "Sheet Metal Flashing and Trim."

3.3 INSTALLATION OF STANDING-SEAM METAL ROOF PANELS

- A. Standing-Seam Metal Roof Panel Installation: Fasten metal roof panels to supports with concealed clips at each standing-seam joint at location, spacing, and with fasteners recommended in writing by manufacturer.
 - 1. Install clips to supports with self-tapping fasteners.
 - 2. Install pressure plates at locations indicated in manufacturer's written installation instructions.

3. Snap Joint: Nest standing seams and fasten together by interlocking and completely engaging factory-applied sealant.
 4. Seamed Joint: Crimp standing seams with manufacturer-approved, motorized seamer tool so clip, metal roof panel, and factory-applied sealant are completely engaged.
 5. Watertight Installation:
 - a. Apply a continuous ribbon of sealant or tape to seal joints of metal panels, using sealant or tape as recommend in writing by manufacturer as needed to make panels watertight.
 - b. Provide sealant or tape between panels and protruding equipment, vents, and accessories.
 - c. At panel splices, nest panels with minimum 6-inch end lap, sealed with sealant and fastened together by interlocking clamping plates.
- B. Accessory Installation: Install accessories with positive anchorage to building and weathertight mounting and provide for thermal expansion. Coordinate installation with flashings and other components.
- C. Flashing and Trim: Comply with performance requirements, manufacturer's written installation instructions, and SMACNA's "Architectural Sheet Metal Manual." Provide concealed fasteners where possible and set units true to line and level as indicated. Install work with laps, joints, and seams that will be permanently watertight and weather resistant.

3.4 CLEANING AND PROTECTION

- A. Remove temporary protective coverings and strippable films, if any, as metal panels are installed, unless otherwise indicated in manufacturer's written installation instructions. On completion of metal panel installation, clean finished surfaces as recommended by metal panel manufacturer. Maintain in a clean condition during construction.

END OF SECTION 074113.16

SECTION 074116 - INSULATED METAL ROOF PANELS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification Sections, apply to work of this section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Standing-seam-profile, foamed-insulation-core metal roof panels.

1.3 ACTION SUBMITTALS

- A. Product Data:
 - 1. For insulated metal roof panels.
 - a. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each type of panel and accessory.
- B. Shop Drawings:
 - 1. Include fabrication and installation layouts of insulated metal roof panels; details of edge conditions, joints, panel profiles, corners, anchorages, attachment system, trim, flashings, closures, and accessories; and special details.
 - 2. Accessories: Include details of the flashing, trim, and anchorage systems, at a scale of not less than 1-1/2 inches per 12 inches.

1.4 INFORMATIONAL SUBMITTALS

- A. Test and Evaluation Reports:
 - 1. Product Test Reports: For insulated metal roof panels, for tests performed by a qualified testing agency.
- B. Qualification Statements: For roof installers.
- C. Sample warranties.

1.5 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For insulated metal roof panels.

1.6 QUALITY ASSURANCE

- A. Manufacturer/Source: Provide metal panel assemblies and accessories from a single manufacturer approved under an accredited third-party quality control program.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Protect products of metal panel system during shipping, handling, and storage to prevent staining, denting, deterioration of components, or other damage. Protect panels and trim bundles during shipping. Protect painted surfaces with a protective covering before shipping.
- B. Unload, store, and erect insulated metal roof panels in a manner to prevent bending, warping, twisting, and surface damage.
- C. Store in accordance with Manufacturer's written instructions. Provide wood collars for stacking and handling in the field. Store insulated metal roof panels to ensure dryness, with positive slope for drainage of water. Do not store insulated metal roof panels in contact with other materials that might cause staining, denting, or other surface damage.
- D. Shield foam insulated metal panels from direct sunlight until installation
- E. Retain strippable protective covering on insulated metal roof panels during installation.

1.8 FIELD CONDITIONS

- A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit assembly of insulated metal roof panels to be performed in accordance with manufacturers' written installation instructions and warranty requirements.

1.9 COORDINATION

- A. Coordinate sizes and locations of roof curbs, equipment supports, and roof penetrations with actual equipment provided.
- B. Coordinate insulated metal roof panel installation with rain drainage work, flashing, trim, construction of soffits, and other adjoining work to provide a leakproof, secure, and noncorrosive installation.

1.10 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace components of insulated metal roof panel systems that fail in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Structural failures, including rupturing, cracking, or puncturing.
 - b. Deterioration of metals and other materials beyond normal weathering.
 - 2. Warranty Period: Two years from date of Substantial Completion.
- B. The installation contractor shall issue a separate warranty against defects in installed materials and workmanship, beginning from the date of substantial completion of the installation.

- C. Special Warranty on Panel Finishes: Manufacturer's standard form in which manufacturer agrees to repair finish or replace insulated metal roof panels that show evidence of deterioration of factory-applied finishes within specified warranty period.
 - 1. Exposed Panel Finish: Deterioration includes, but is not limited to, the following:
 - a. Color fading more than 5 Hunter units when tested in accordance with ASTM D2244.
 - b. Chalking in excess of a No. 8 rating when tested in accordance with ASTM D4214.
 - c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Structural Performance: Provide insulated metal roof panel systems capable of withstanding the effects of the following loads, based on testing in accordance with ASTM E72:
 - 1. Wind Loads: As indicated on Drawings.
 - a. Roof Panel Wind Uplift Testing: Certify capacity of metal panels by testing of proposed assembly per ASTM E 72 or ASTM E 1592.
 - 2. Other Design Loads: As indicated on Drawings.
 - 3. Deflection Limits: For wind loads, no greater than 1/180 of the span.
- B. Air Infiltration: Air leakage of not more than 0.023 cfm/sq. ft. when tested in accordance with ASTM E1680 at the following test-pressure difference:
 - 1. Test-Pressure Difference: 12 lbf/sq. ft..
- C. Water Penetration under Static Pressure: No uncontrolled water penetration when tested in accordance with ASTM E1646 at the following test-pressure difference:
 - 1. Test-Pressure Difference: 20 lbf/sq. ft..
- D. Wind-Uplift Resistance: Provide metal roof panel assemblies that comply with UL 580 for wind-uplift-resistance class indicated.
 - 1. Uplift Rating: See Structural Drawings.
- E. FM Approvals Listing: Provide insulated metal roof panels and component materials that comply with requirements in FM Approvals 4471 as part of a panel roofing system and that are listed in FM's "Approval Guide" for Class 1 or noncombustible construction, as applicable. Identify materials with FM Global markings.
 - 1. Fire/Windstorm Classification: See Structural Drawings.
 - 2. Hail Resistance: SH.
- F. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.
 - 1. Temperature Change (Range): 120 deg F, ambient; 180 deg F, material surfaces.

2.2 INSULATED METAL ROOF PANELS, GENERAL

- A. Standing Seam, Foamed-Insulation-Core Metal Roof Panels: Structural metal panels consisting of an exterior standing seam with an interior tongue and groove joint, coupled with a vapor seal in the standing seam, and provides superior resistance to air and moisture intrusion. Attached with concealed fasteners to the structure.
1. Basis of Design: Metl-Span, CFR Insulated Metal Panel.
 2. G-90 Galvanized Coated Steel: ASTM A 653 or Aluminum-Zinc Alloy-Coated Steel: ASTM A 792/A 792M, structural quality, Grade 50, Coating Class AZ50 (Grade 340, Coating Class AZM150), pre-painted by the coil-coating process per ASTM A 755/A 755M.
 3. Exterior Face Sheet: 24 ga coated thickness, with embossed surface Mesa profile between ribs.
 - a. Finish: Fluoropolymer two-coat metallic color system, 0.2 – 0.3 mil primer with 0.7 - 0.8 mil 70 percent PVDF fluoropolymer color coat.
 - b. Color: Smoke Gray.
 4. Interior Face Sheet: 26 ga coated thickness, with embossed surface Mesa profile.
 - a. Finish: Fluoropolymer two-coat metallic color system, 0.2 – 0.3 mil primer with 0.7 - 0.8 mil 70 percent PVDF fluoropolymer color coat.
 - b. Color: Igloo White.
 5. Endlaps: Provide panels with factory endlaps, notching, swedging and backer plates; where panel lengths permit.
 6. Low Eave Treatment: Provide cutback for trim/gutter installation; where panel lengths permit.
 7. Panel Width: 42 inches.
 8. Panel Thickness: 3 inch.
 9. Insulating Core: Polyurethane with zero ozone depletion potential blowing agent
 - a. Closed Cell Content: 90% or more as determined by ASTM D 6226.
 - b. Compressive Strength: As required to meet structural performance requirements and with a minimum of 22 psi as determined by ASTM D 1621.
 - c. Shear Strength: As required to meet structural performance requirements and with a minimum of 36 psi as determined by ASTM C 273.
 - d. Tensile Strength: As required to meet structural performance requirements and with a minimum of 41 psi ASTM D 1623.
 - e. Minimum Density: 2.0 pcf as determined by ASTM D 1622.
 - f. Thermal Resistance (R-Value): R-26.2 min. as determined by ASTM C 518.

2.3 MISCELLANEOUS MATERIALS

- A. Miscellaneous Metal Sub-framing and Furring: ASTM C645, cold-formed, metallic-coated steel sheet, minimum ASTM A653/A653M, G90 coating designation or ASTM A792/A792M, Class AZ50 coating designation. Provide manufacturer's standard sections as required for support and alignment of insulated metal roof panel system.
- B. Panel Accessories: Provide components required for a complete, weathertight panel system, including trim, copings, fasciae, mullions, sills, corner units, clips, flashings, sealants, gaskets, fillers, closure strips, and similar items. Match material and finish of

insulated metal roof panels unless otherwise indicated.

1. Closures: Provide closures at eaves and ridges, fabricated of same metal as insulated metal roof panels.
 2. Backing Plates: Provide metal backing plates at panel end splices, fabricated from material recommended by manufacturer.
 3. Closure Strips: Closed-cell, expanded, cellular, rubber or crosslinked, polyolefin-foam or closed-cell laminated polyethylene; minimum 1-inch- thick, flexible closure strips; cut or pre-molded to match insulated metal roof panel profile. Provide closure strips where indicated or necessary to ensure weathertight construction.
- C. Flashing and Trim: Provide flashing and trim formed from same material as exterior facings of insulated metal roof panels as required to seal against weather and to provide finished appearance. Locations include, but are not limited to, eaves, rakes, corners, bases, framed openings, ridges, fasciae, and fillers. Finish flashing and trim with same finish system as adjacent insulated metal roof panels.
- D. Gutters: Formed from same material, finish, and color as exterior facings of panels, complete with end pieces, outlet tubes, and other special pieces as required. Fabricate in minimum 96-inch- long sections, of size and metal thickness in accordance with manufacturer's recommendations. Furnish gutter supports spaced a maximum of 36 inches o.c., fabricated from same metal as gutters. Provide wire ball strainers of compatible metal at outlets. Finish gutters to match roof fascia and rake trim.
- E. Downspouts: Formed from same material, finish, and color as exterior facings of roof panels. Fabricate in 10 ft.- long sections, complete with formed elbows and offsets, of size and metal thickness in accordance with manufacturer's recommendations. Finish downspouts to match gutters.
- F. Panel Fasteners: Self-tapping screws designed to withstand design loads and other acceptable fasteners recommended by metal panel manufacturer. Provide EPDM or PVC sealing washers for exposed fasteners.
1. Galvanized-Steel Fasteners: Provide corrosion-resistant fasteners with heads matching color of metal panels by means of factory-applied coating.
- G. Panel Sealants: Provide sealant types recommended by manufacturer that are compatible with panel materials, are nonstaining, and do not damage panel finish.
1. Sealant Tape: Pressure-sensitive, 100 percent solids, gray polyisobutylene compound sealant tape with release-paper backing. Provide permanently elastic, nonsag, nontoxic, nonstaining tape 1/2 inch wide and 1/8 inch thick.
 2. Joint Sealant: ASTM C920; elastomeric polyurethane or silicone sealant; of type, grade, class, and use classifications required to seal joints in insulated metal roof panels and remain weathertight; and as recommended in writing by insulated metal roof panel manufacturer.
 3. Butyl-Rubber-Based, Solvent-Release Sealant: ASTM C1311.

2.4 FABRICATION

- A. Fabricate and finish insulated metal roof panels and accessories at the factory, by manufacturer's standard procedures and processes, as necessary to fulfill indicated performance requirements demonstrated by laboratory testing. Comply with indicated profiles and with dimensional and structural requirements.
- B. Provide panel profile, including major ribs and intermediate stiffening ribs, if any, for full length of panel.
- C. Sheet Metal Flashing and Trim: Fabricate flashing and trim to comply with manufacturer's recommendations.
 - 1. Form exposed sheet metal accessories that are without excessive oil canning, buckling, and tool marks and that are true to line and levels indicated, with exposed edges folded back to form hems.
 - 2. Seams: Fabricate nonmoving seams in accessories with flat-lock seams. Tin edges to be seamed, form seams, and solder.
 - 3. Sealed Joints: Form nonexpansion, but movable, joints in metal to accommodate sealant and to comply with manufacturer's recommendations.
 - 4. Conceal fasteners and expansion provisions where possible. Exposed fasteners are not allowed on faces of accessories exposed to view.
 - 5. Fabricate cleats and attachment devices from same material as accessory being anchored or from compatible, noncorrosive metal recommended in writing by insulated metal roof panel manufacturer.
 - a. Size: As recommended by insulated metal roof panel manufacturer for application but not less than thickness of metal being secured.

2.5 FINISHES

- A. Protect mechanical and painted finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- B. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Noticeable variations in same piece are unacceptable. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.
- C. Exterior Facings and Accessories:
 - 1. Two-Coat Fluoropolymer: Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
- D. Interior Facings:
 - 1. Two-Coat Fluoropolymer: Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.

instructions.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances, insulated metal roof panel supports, and other conditions affecting performance of the Work.
 - 1. Inspect framing that will support insulated metal panels to determine if support components are installed as indicated on approved shop drawings and are within tolerances acceptable to metal panel manufacturer and installer. Confirm presence of acceptable framing members at recommended spacing to match installation requirements of metal panels.
 - 2. Panel Support Tolerances: Confirm that metal panel supports are within tolerances acceptable to metal panel manufacturer but not greater than the following:
 - a. 1/4 inch in 20 foot in any direction.
 - b. 3/8 inch over any single roof plane.
 - c. At purlin spacing 7 feet or less: 1/8 inches, out only.
- B. Examine roughing-in for components and systems penetrating insulated metal roof panels to verify actual locations of penetrations relative to seam locations of insulated metal roof panels before installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Miscellaneous Supports: Install subframing, furring, and other miscellaneous panel support members and anchorages in accordance with ASTM C754 and insulated metal roof panel manufacturer's written recommendations.

3.3 INSTALLATION OF INSULATED METAL ROOF PANELS

- A. Standing seamed, concealed-fastener insulated metal panels: Install metal panel system in accordance with manufacturer's written instructions, approved shop drawings, and project drawings. Install metal panels in orientation, sizes, and locations indicated. Anchor panels and other components securely in place. Provide for thermal and structural movement.
- B. Attach panels to metal framing using clips, fasteners, and sealants recommended for application by metal panel manufacturer.
 - 1. Fasten metal panels to supports with fasteners at each location indicated on approved shop drawings, at spacing and with fasteners recommended by manufacturer.
 - 2. Cut panels in field where required using manufacturer's recommended methods.

3. Provide weatherproof jacks for pipe and conduit penetrating metal panels.
 4. Dissimilar Materials: Where elements of metal panel system will come into contact with dissimilar materials or corrosive substrates, protect against galvanic action as recommended by metal panel manufacturer.
- C. Attach panel flashing trim pieces to supports using recommended fasteners and joint sealers.
- D. Joint Sealers: Install tape sealers and liquid sealants where indicated and where required for weatherproof performance of metal panel assemblies.
1. Seal panel side and perimeter joints using joint sealers indicated in manufacturer's instructions.
 2. Prepare joints and apply sealants per Section 079200 "Joint Sealants."
- E. Standing-Seam, Foamed-Insulation-Core Metal Roof Panels: Fasten insulated metal roof panels to supports with concealed clips at each standing-seam joint at location, spacing, and with fasteners recommended in writing by manufacturer.
1. Install clips to supports with self-tapping fasteners.
 2. Seamed Joint: Crimp standing seams with manufacturer-approved, motorized seamer tool so cleat, insulated metal roof panel, and factory-applied side-lap sealant are completely engaged.
- F. Accessory Installation: Install accessories with positive anchorage to building and weathertight mounting and provide for thermal expansion. Coordinate installation with flashings and other components.
1. Install components required for a complete insulated metal roof panel system including trim, copings, corners, seam covers, flashings, sealants, gaskets, fillers, closure strips, and similar items. Provide types indicated by insulated metal panel manufacturers; or, if not indicated, provide types recommended in writing by metal roof panel manufacturer.
- G. Flashing and Trim: Comply with performance requirements and manufacturer's written installation instructions. Provide concealed fasteners where possible and set units true to line and level. Install work with laps, joints, and seams that are permanently watertight and weather resistant.
1. Install exposed flashing and trim that is without buckling and tool marks, and that is true to line and levels indicated, with exposed edges folded back to form hems. Install sheet metal flashing and trim to fit substrates and achieve waterproof performance.
 2. Expansion Provisions: Provide for thermal expansion of exposed flashing and trim. Space movement joints at a maximum of 10 ft. with no joints allowed within 24 inches of corner or intersection. Where lapped expansion provisions cannot be used or would not be sufficiently waterproof, form expansion joints of intermeshing hooked flanges, not less than 1 inch deep, filled with mastic sealant (concealed within joints).
- H. Gutters: Join sections with riveted and soldered or lapped and sealed joints. Attach gutters to eave with gutter hangers spaced not more than 36 inches o.c. using

manufacturer's standard fasteners. Provide end closures and seal watertight with sealant. Provide for thermal expansion.

- I. Downspouts: Join sections with telescoping joints. Provide fasteners designed to hold downspouts securely 1 inch away from walls; locate fasteners at top and bottom and at approximately 60 inches o.c. in between.
 - 1. Connect downspouts to existing underground drainage system.
- J. Pipe and Conduit Penetrations: Fasten and seal to metal roof panels as recommended by manufacturer.

3.4 FIELD QUALITY CONTROL

- A. Engage a factory-authorized service representative to test and inspect completed insulated metal roof panel installation, including accessories. Report results in writing.
- B. Remove and replace applications where tests and inspections indicate that they do not comply with specified requirements.
- C. Additional tests and inspections, at Contractor's expense, are performed to determine compliance of replaced or additional work with specified requirements.
- D. Prepare test and inspection reports.

3.5 CLEANING AND PROTECTION

- A. Remove temporary protective coverings and strippable films, if any, as insulated metal roof panels are installed, unless otherwise indicated in manufacturer's written installation instructions. On completion of insulated metal roof panel installation, clean finished surfaces as recommended by insulated metal roof panel manufacturer. Maintain in a clean condition during construction.
- B. Replace insulated metal roof panels that have been damaged or have deteriorated beyond successful repair by finish touchup or similar minor repair procedures.

END OF SECTION 074116

SECTION 075323 - ETHYLENE-PROPYLENE-DIENE-MONOMER (EPDM) ROOFING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification Sections, apply to work of this section.

1.2 SUMMARY

- A. Section Includes:

1. Adhered ethylene-propylene-diene-terpolymer (EPDM) roofing system.
2. Accessory roofing materials.
3. Substrate board.
4. Roof insulation.
5. Insulation accessories and cover board.
6. Asphalt materials.
7. Walkways.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.

1. For insulation and roof system component fasteners, include copy of FM Approvals' RoofNav listing.

- B. Shop Drawings: Include roof plans, sections, details, and attachments to other work, including the following:

1. Layout and thickness if insulation.
2. Base flashings and membrane terminations.
3. Flashing details at penetrations.
4. Tapered insulation, thickness, and slopes.
5. Roof plan showing orientation of steel roof deck and orientation of roof membrane and fastening spacings and patterns for mechanically fastened roofing system.
6. Insulation fastening patterns for corner, perimeter, and field-of-roof locations.
7. Tie-in with air barrier.

- C. Wind Uplift Resistance Submittal: For roofing system, indicating compliance with wind uplift performance requirements.

1.4 INFORMATIONAL SUBMITTALS

- A. Manufacturer Certificates:

1. Performance Requirement Certificate: Signed by roof membrane manufacturer, certifying that roofing system complies with requirements specified in "Performance Requirements" Article.
 - a. Submit evidence of complying with performance requirements.
 2. Special Warranty Certificate: Signed by roof membrane manufacturer, certifying that all materials supplied under this Section are acceptable for special warranty.
- B. Product Test Reports: For components of roof membrane and insulation, for tests performed by a qualified testing agency, indicating compliance with specified requirements.
- C. Field Test Reports:
1. Concrete internal relative humidity test reports.
 2. Fastener-pullout test results and manufacturer's revised requirements for fastener patterns.
- D. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

- A. Certified statement from existing roof membrane manufacturer stating that existing roof warranty has not been affected by Work performed under this Section.

1.6 QUALITY ASSURANCE

- A. Qualifications:
 1. Manufacturers: A qualified manufacturer that is listed in FM Approvals' RoofNav for roofing system identical to that used for this Project.
 2. Installers: A qualified firm that is approved, authorized, or licensed by roofing system manufacturer to install manufacturer's product and that is eligible to receive manufacturer's special warranty.

1.7 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace components of roofing system that fail in materials or workmanship within specified warranty period.
 1. Warranty Period: 20 years from Date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Accelerated Weathering: Roof membrane to withstand 2000 hours of exposure when tested in accordance with ASTM G152, ASTM G154, or ASTM G155.

- B. Impact Resistance: Roof membrane to resist impact damage when tested in accordance with ASTM D3746, ASTM D4272, or the "Resistance to Foot Traffic Test" in FM Approvals 4470.
- C. FM Approvals' RoofNav Listing: Roof membrane, base flashings, and component materials comply with requirements in FM Approvals 4450 or FM Approvals 4470 as part of a roofing system, and are listed in FM Approvals' RoofNav for Class 1 or noncombustible construction, as applicable. Identify materials with FM Approvals Certification markings.
 - 1. Fire/Windstorm Classification: See structural drawings.
 - 2. Hail-Resistance Rating: FM Global Property Loss Prevention Data Sheet 1-34 MH.
- D. SPRI's Directory of Roof Assemblies Listing: Roof membrane, base flashings, and component materials comply with requirements in FM Approvals 4450 or FM Approvals 4470 as part of a roofing system, and are listed in SPRI's Directory of Roof Assemblies for roof assembly identical for that specified for this Project.
 - 1. Wind Uplift Load Capacity: See structural drawings.

2.2 ETHYLENE-PROPYLENE-DIENE-TERPOLYMER (EPDM) ROOFING

- A. EPDM Sheet: ASTM D4637/D4637M, Type II, scrim or fabric internally reinforced, EPDM sheet.
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Carlisle Syntec Systems.
 - b. Johns Manville; a Berkshire Hathaway company.
 - c. Roofing Products International, Inc.
 - d. Versico Roofing Systems; Carlisle Construction Materials.
 - 2. Thickness: 60 mils, nominal.
 - 3. Exposed Face Color: Black.

2.3 ACCESSORY ROOFING MATERIALS

- A. General: Accessory materials recommended by roofing system manufacturer for intended use and compatible with other roofing components.
- B. Sheet Flashing: 60-mil- thick EPDM, partially cured or cured, according to application.
- C. Protection Sheet: Epichlorohydrin or neoprene nonreinforced flexible sheet, 55 to 60 mils thick, recommended by EPDM manufacturer for resistance to hydrocarbons, non-aromatic solvents, grease, and oil.
- D. Prefabricated Pipe Flashings: As recommended by roof membrane manufacturer.
- E. Bonding Adhesive: Manufacturer's standard.

- F. Modified Asphaltic Fabric-Backed Membrane Adhesive: Roofing system manufacturer's standard modified asphalt, asbestos-free, cold-applied adhesive formulated for compatibility and use with fabric-backed membrane roofing.
- G. Seaming Material: Manufacturer's standard, synthetic-rubber polymer primer and 3-inch- wide minimum, butyl splice tape with release film.
- H. Lap Sealant: Manufacturer's standard, single-component sealant, colored to match membrane roofing.
- I. Water Cutoff Mastic: Manufacturer's standard butyl mastic sealant.
- J. Metal Termination Bars: Manufacturer's standard, predrilled stainless steel or aluminum bars, approximately 1 by 1/8 inch thick; with anchors.
- K. Fasteners: Factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions in FM Approvals 4470, designed for fastening components to substrate, and acceptable to roofing system manufacturer.
- L. Miscellaneous Accessories: Provide pourable sealers, preformed cone and vent sheet flashings, molded pipe boot flashings, preformed inside and outside corner sheet flashings, reinforced EPDM securement strips, T-joint covers, in-seam sealants, termination reglets, cover strips, and other accessories.
 - 1. Provide white flashing accessories for white EPDM membrane roofing.

2.4 SUBSTRATE BOARD

- A. Glass-Mat Gypsum Roof Substrate Board: ASTM C1177/C1177M, water-resistant gypsum board.
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. CertainTeed; SAINT-GOBAIN.
 - b. Georgia-Pacific Gypsum LLC.
 - c. USG Corporation.
 - 2. Thickness: Type X, 5/8 inch.
 - 3. Surface Finish: Factory primed.
- B. Fasteners: Factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions in FM Approvals 4470, designed for fastening substrate panel to roof deck.

2.5 ROOF INSULATION

- A. Extruded-Polystyrene Board Insulation: ASTM C578, Type IV, 1.45-lb/cu. ft. minimum density, 25 psi minimum compressive strength square edged.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. DiversiFoam Products.
 - b. Kingspan Insulation LLC.
 - c. Owens Corning.
 - d. The Dow Chemical Company.
2. Thermal Resistance: R-value of 5.0 per 1 inch.
3. Size: 48 by 48 inches.

B. Tapered Insulation: Provide factory-tapered insulation boards.

1. Material: Match roof insulation.
2. Minimum Thickness: 1/4 inch.
3. Slope:
 - a. Roof Field: 1/4 inch per foot unless otherwise indicated on Drawings.
 - b. Saddles and Crickets: 1/2 inch per foot unless otherwise indicated on Drawings.

2.6 INSULATION ACCESSORIES AND COVER BOARD

- A. Fasteners: Factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions in FM Approvals 4470, designed for fastening roof insulation and cover boards to substrate, and acceptable to roofing system manufacturer.
- B. Insulation Adhesive: Insulation manufacturer's recommended adhesive formulated to attach roof insulation to substrate or to another insulation layer as follows:

2.7 ASPHALT MATERIALS

- A. Roofing Asphalt: ASTM D312/D312M, Type III or Type IV.
- B. Asphalt Primer: ASTM D41/D41M.

2.8 WALKWAYS

- A. Flexible Walkways: Factory-formed, nonporous, heavy-duty, slip-resisting, surface-textured walkway pads, approximately 3/16 inch thick and acceptable to roofing system manufacturer.
 1. Size: Approximately 36 by 60 inches.
 2. Color: Contrasting with roof membrane.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements and other conditions affecting performance of the Work.

3.2 PREPARATION

- A. Perform fastener-pullout tests in accordance with roof system manufacturer's written instructions.
 - 1. Submit test result within 24 hours of performing tests.
 - a. Include manufacturer's requirements for any revision to previously submitted fastener patterns required to achieve specified wind uplift requirements.
- B. Install sound-absorbing insulation strips in accordance with acoustical roof deck manufacturer's written instructions.

3.3 INSTALLATION OF ROOFING, GENERAL

- A. Install roofing system in accordance with roofing system manufacturer's written instructions, FM Approvals' RoofNav assembly requirements, and FM Global Property Loss Prevention Data Sheet 1-29.
- B. Complete terminations and base flashings and provide temporary seals to prevent water from entering completed sections of roofing system at end of workday or when rain is forecast. Remove and discard temporary seals before beginning work on adjoining roofing.
- C. Install roof membrane and auxiliary materials to tie in to existing roofing to maintain weathertightness of transition.
- D. Coordinate installation and transition of roofing system component serving as an air barrier with air barrier specified under other Sections.

3.4 INSTALLATION OF SUBSTRATE BOARD

- A. Install substrate board with long joints in continuous straight lines, with end joints staggered not less than 24 inches in adjacent rows.
 - 1. At steel roof decks, install substrate board at right angle to flutes of deck.
 - a. Locate end joints over crests of steel roof deck.
 - 2. Tightly butt substrate boards together.
 - 3. Cut substrate board to fit tight around penetrations and projections, and to fit tight to intersecting sloping roof decks.
 - 4. Fasten substrate board to top flanges of steel deck in accordance with recommendations in FM Approvals' RoofNav listed roof assembly requirements for specified Windstorm Resistance Classification and FM Global Property Loss Prevention Data Sheet 1-29.
 - 5. Fasten substrate board to top flanges of steel deck to resist uplift pressure at corners, perimeter, and field of roof in accordance with roofing system manufacturers' written instructions.
 - 6. Loosely lay substrate board over roof deck.

3.5 INSTALLATION OF INSULATION

- A. Coordinate installing roofing system components, so insulation is not exposed to precipitation or left exposed at end of workday.
- B. Comply with roofing system and insulation manufacturer's written instructions for installing roof insulation.
- C. Installation Over Metal Decking:
 - 1. Install base layer of insulation with joints staggered not less than 24 inches in adjacent rows and with long joints continuous at right angle to flutes of decking.
 - a. Locate end joints over crests of decking.
 - b. Where installing composite and noncomposite insulation in two or more layers, install noncomposite board insulation for bottom layer and intermediate layers, if applicable, and install composite board insulation for top layer.
 - c. Trim insulation neatly to fit around penetrations and projections, and to fit tight to intersecting sloping roof decks.
 - d. Make joints between adjacent insulation boards not more than 1/4 inch in width.
 - e. At internal roof drains, slope insulation to create a square drain sump with each side equal to the diameter of the drain bowl plus 24 inches.
 - 1) Trim insulation so that water flow is unrestricted.
 - f. Fill gaps exceeding 1/4 inch with insulation.
 - g. Cut and fit insulation within 1/4 inch of nailers, projections, and penetrations.
 - h. Loosely lay base layer of insulation units over substrate.
 - i. Mechanically attach base layer of insulation and substrate board using mechanical fasteners specifically designed and sized for fastening specified board-type roof insulation to metal decks.
 - 1) Fasten insulation in accordance with requirements in FM Approvals' RoofNav for specified Windstorm Resistance Classification.
 - 2) Fasten insulation to resist specified uplift pressure at corners, perimeter, and field of roof.
 - 2. Install upper layers of insulation and tapered insulation with joints of each layer offset not less than 12 inches from previous layer of insulation.
 - a. Staggered end joints within each layer not less than 24 inches in adjacent rows.
 - b. Install with long joints continuous and with end joints staggered not less than 12 inches in adjacent rows.
 - c. Trim insulation neatly to fit around penetrations and projections, and to fit tight to intersecting sloping roof decks.
 - d. Make joints between adjacent insulation boards not more than 1/4 inch in width.
 - e. At internal roof drains, slope insulation to create a square drain sump with each side equal to the diameter of the drain bowl plus 24 inches.
 - f. Trim insulation so that water flow is unrestricted.
 - g. Fill gaps exceeding 1/4 inch with insulation.

- h. Cut and fit insulation within 1/4 inch of nailers, projections, and penetrations.
- i. Loosely lay each layer of insulation units over substrate.
- j. Adhere each layer of insulation to substrate using adhesive in accordance with FM Approvals' RoofNav listed roof assembly requirements for specified Windstorm Resistance Classification and FM Global Property Loss Prevention Data Sheet 1-29, as follows:
 - 1) Set each layer of insulation in a solid mopping of hot roofing asphalt, applied within plus or minus 25 deg F of equiviscous temperature.
 - 2) Set each layer of insulation in ribbons of bead-applied insulation adhesive, firmly pressing and maintaining insulation in place.
 - 3) Set each layer of insulation in a uniform coverage of full-spread insulation adhesive, firmly pressing and maintaining insulation in place.

3.6 ADHERED ROOFING INSTALLATION

- A. Adhere roof membrane over area to receive roofing in accordance with roofing system manufacturer's written instructions.
- B. Unroll membrane roof membrane and allow to relax before installing.
- C. Start installation of roofing in presence of roofing system manufacturer's technical personnel.
- D. Accurately align roof membrane, and maintain uniform side and end laps of minimum dimensions required by manufacturer. Stagger end laps.
- E. Bonding Adhesive: Apply to substrate and underside of roof membrane at rate required by manufacturer, and allow to partially dry before installing roof membrane. Do not apply to splice area of roof membrane.
- F. Hot Roofing Asphalt: Apply a solid mopping of hot roofing asphalt to substrate at temperature and rate required by manufacturer, and install fabric-backed roofing. Do not apply to splice area of roof membrane.
- G. Fabric-Backed Roof Membrane Adhesive: Apply to substrate at rate required by manufacturer, and install fabric-backed roof membrane.
- H. In addition to adhering, mechanically fasten roof membrane securely at terminations, penetrations, and perimeters.
- I. Apply roof membrane with side laps shingled with slope of roof deck where possible.
- J. Adhesive Seam Installation: Clean both faces of splice areas, apply splicing cement.
 - 1. Firmly roll side and end laps of overlapping roof membrane to ensure a watertight seam installation.
 - 2. Apply lap sealant and seal exposed edges of roofing terminations.
 - 3. Apply a continuous bead of in-seam sealant before closing splice if required by roofing system manufacturer.

- K. Tape Seam Installation: Clean and prime both faces of splice areas, apply splice tape.
 - 1. Firmly roll side and end laps of overlapping roof membrane to ensure a watertight seam installation.
 - 2. Apply lap sealant and seal exposed edges of roofing terminations.
- L. Factory-Applied Seam Tape Installation: Clean and prime surface to receive tape.
 - 1. Firmly roll side and end laps of overlapping roof membrane to ensure a watertight seam installation.
 - 2. Apply lap sealant and seal exposed edges of roofing terminations.
- M. Spread sealant or mastic bed over deck-drain flange at roof drains, and securely seal roof membrane in place with clamping ring.
- N. Adhere protection sheet over roof membrane at locations indicated.

3.7 INSTALLATION OF BASE FLASHING

- A. Install sheet flashings and preformed flashing accessories, and adhere to substrates in accordance with roofing system manufacturer's written instructions.
- B. Apply bonding adhesive to substrate and underside of sheet flashing at required rate, and allow to partially dry. Do not apply to seam area of flashing.
- C. Flash penetrations and field-formed inside and outside corners with cured or uncured sheet flashing.
- D. Clean splice areas, apply splicing cement, and firmly roll side and end laps of overlapping sheets to ensure a watertight seam installation. Apply lap sealant and seal exposed edges of sheet flashing terminations.
- E. Terminate and seal top of sheet flashings and mechanically anchor to substrate through termination bars.

3.8 INSTALLATION OF WALKWAYS

- A. Flexible Walkways: Install walkway products in accordance with manufacturer's written instructions.
 - 1. Install flexible walkways at the following locations:
 - a. Perimeter of each rooftop unit.
 - b. Between each rooftop unit location, creating a continuous path connecting rooftop unit locations.
 - c. Between each roof hatch and each rooftop unit location or path connecting rooftop unit locations.
 - d. Top and bottom of each roof access ladder.
 - e. Between each roof access ladder and each rooftop unit location or path connecting rooftop unit locations.
 - f. Locations indicated on Drawings.
 - g. As required by roof membrane manufacturer's warranty requirements.

2. Provide 6-inch clearance between adjoining pads.
3. Adhere walkway products to substrate with compatible adhesive in accordance with roofing system manufacturer's written instructions.

3.9 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to inspect substrate conditions, surface preparation, roof membrane application, flashings, protection, and drainage components, and to furnish reports to A/E.
- B. Perform the following tests:
 1. Infrared Thermography: Testing agency surveys entire roof area using infrared color thermography in accordance with ASTM C1153.
 - a. Perform tests before overlying construction is placed.
 - b. After infrared scan, locate specific areas of leaks by electrical capacitance/impedance testing or nuclear hydrogen detection testing.
 - c. After testing, repair leaks, repeat tests, and make further repairs until roofing and flashing installations are watertight.
 - 1) Cost of retesting is Contractor's responsibility.
 - d. Testing agency to prepare survey report of initial scan indicating locations of entrapped moisture, if any.
- C. Final Roof Inspection: Arrange for roofing system manufacturer's technical personnel to inspect roofing installation on completion, in presence of A/E, and to prepare inspection report.
- D. Repair or remove and replace components of roofing system where inspections indicate that they do not comply with specified requirements.

3.10 PROTECTING AND CLEANING

- A. Protect roofing system from damage and wear during remainder of construction period. When remaining construction does not affect or endanger roofing system, inspect roofing system for deterioration and damage, describing its nature and extent in a written report, with copies to A/E and Owner.
- B. Correct deficiencies in or remove roofing system that does not comply with requirements, repair substrates, and repair or reinstall roofing system to a condition free of damage and deterioration at time of Substantial Completion and in accordance with warranty requirements.
- C. Clean overspray and spillage from adjacent construction using cleaning agents and procedures recommended by manufacturer of affected construction.

END OF SECTION 075323

SECTION 076200 - SHEET METAL FLASHING AND TRIM

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification Sections, apply to work of this section.

1.2 SUMMARY

A. Section Includes:

1. Manufactured reglets with counterflashing.
2. Formed roof-drainage sheet metal fabrications.
3. Formed low-slope roof sheet metal fabrications.
4. Formed wall sheet metal fabrications.

B. Related Requirements:

1. Section 061000 "Rough Carpentry" for wood nailers, curbs, and blocking.
2. Section 077100 "Roof Specialties" for manufactured copings, roof-edge specialties, roof-edge drainage systems, reglets, and counterflashings.
3. Section 077200 "Roof Accessories" for set-on-type curbs, equipment supports, roof hatches, vents, and other manufactured roof accessory units.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1. Review construction schedule. Verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
2. Review requirements for insurance and certificates if applicable.
3. Review sheet metal flashing observation and repair procedures after flashing installation.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: For sheet metal flashing and trim.

1. Detail fabrication and installation layouts, expansion-joint locations, and keyed details. Distinguish between shop- and field-assembled Work.
2. Include identification of material, thickness, weight, and finish for each item and location in Project.
3. Include details of termination points and assemblies.
4. Include details of expansion joints and expansion-joint covers, including showing direction of expansion and contraction from fixed points.

5. Include details of roof-penetration flashing.
 6. Include details of edge conditions, including eaves, ridges, valleys, rakes, crickets, flashings, and counterflashings.
 7. Include details of special conditions.
 8. Include details of connections to adjoining work.
- C. Samples: For each exposed product and for each color and texture specified, 12 inches long by actual width.
- D. Samples for Initial Selection: Manufacturer's standard color sheets, showing full range of available colors for each type of exposed finish.

1.5 INFORMATIONAL SUBMITTALS

- A. Product Certificates: For each type of coping and roof edge flashing that is ANSI/SPRI/FM 4435/ES-1 tested.
- B. Evaluation Reports: For copings and roof edge flashing, from ICC-ES showing compliance with ANSI/SPRI/FM 4435/ES-1.
- C. Sample warranty.

1.6 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For sheet metal flashing and trim, and its accessories.

1.7 QUALITY ASSURANCE

- A. Fabricator Qualifications: Employs skilled workers who custom fabricate sheet metal flashing and trim similar to that required for this Project and whose products have a record of successful in-service performance.
1. For copings and roof edge flashings that are ANSI/SPRI/FM 4435/ES-1 tested, shop is to be listed as able to fabricate required details as tested and approved.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Do not store sheet metal flashing and trim materials in contact with other materials that might cause staining, denting, or other surface damage.
1. Store sheet metal flashing and trim materials away from uncured concrete and masonry.
 2. Protect stored sheet metal flashing and trim from contact with water.
- B. Protect strippable protective covering on sheet metal flashing and trim from exposure to sunlight and high humidity, except to extent necessary for period of sheet metal flashing and trim installation.

1.9 COORDINATION

- A. Coordinate sheet metal flashing and trim layout and seams with sizes and locations of penetrations to be flashed, and joints and seams in adjacent materials.
- B. Coordinate sheet metal flashing and trim installation with adjoining roofing and wall materials, joints, and seams to provide leakproof, secure, and noncorrosive installation.

1.10 WARRANTY

- A. Special Warranty on Finishes: Manufacturer agrees to repair finish or replace sheet metal flashing and trim that shows evidence of deterioration of factory-applied finishes within specified warranty period.
 - 1. Exposed Panel Finish: Deterioration includes, but is not limited to, the following:
 - a. Color fading more than 5 Delta E units when tested in accordance with ASTM D2244.
 - b. Chalking in excess of a No. 8 rating when tested in accordance with ASTM D4214.
 - c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.
 - 2. Finish Warranty Period: 10 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Sheet metal flashing and trim assemblies, including cleats, anchors, and fasteners, are to withstand wind loads, structural movement, thermally induced movement, and exposure to weather without failure due to defective manufacture, fabrication, installation, or other defects in construction. Completed sheet metal flashing and trim are not to rattle, leak, or loosen, and are to remain watertight.
- B. Sheet Metal Standard for Flashing and Trim: Comply with NRCA's "The NRCA Roofing Manual: Architectural Metal Flashing, Condensation and Air Leakage Control, and Reroofing" and SMACNA's "Architectural Sheet Metal Manual" requirements for dimensions and profiles shown unless more stringent requirements are indicated.
- C. Manufacture and install roof edge flashings tested in accordance with ANSI/SPRI/FM 4435/ES-1 and capable of resisting the following design pressure:
 - 1. Design Pressure: As indicated on Drawings.
- D. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes to prevent buckling, opening of joints, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects. Base calculations on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.
 - 1. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.

2.2 SHEET METALS

- A. Protect mechanical and other finishes on exposed surfaces from damage by applying strippable, temporary protective film before shipping.
- B. Stainless Steel Sheet: ASTM A240/A240M, Type 304, dead soft, fully annealed; with smooth, flat surface.
 - 1. Finish: ASTM A480/A480M, No. 2D (dull, cold rolled).
- C. Metallic-Coated Steel Sheet: Provide zinc-coated (galvanized) steel sheet in accordance with ASTM A653/A653M, G90 coating designation or aluminum-zinc alloy-coated steel sheet in accordance with ASTM A792/A792M, Class AZ50 coating designation, Grade 40; prepainted by coil-coating process to comply with ASTM A755/A755M.
 - 1. Surface: Smooth, flat and with manufacturer's standard clear acrylic coating on both sides.
 - 2. Exposed Coil-Coated Finish:
 - a. Three-Coat Fluoropolymer: AAMA 621. Fluoropolymer finish containing not less than 70 percent polyvinylidene fluoride (PVDF) resin by weight in both color coat and clear topcoat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
 - b. Siliconized Polyester: Epoxy primer and silicone-modified, polyester-enamel topcoat; with dry film thickness of not less than 0.2 mil for primer and 0.8 mil for topcoat.
 - 3. Color: As selected by A/E from manufacturer's full range.
 - 4. Concealed Finish: Pretreat with manufacturer's standard white or light-colored acrylic or polyester backer finish, consisting of prime coat and wash coat with minimum total dry film thickness of 0.5 mil.

2.3 UNDERLAYMENT MATERIALS

- A. Felt: ASTM D226/D226M, Type II (No. 30), asphalt-saturated organic felt; nonperforated.
- B. Self-Adhering, High-Temperature Sheet Underlayment: Minimum 30 mils thick, consisting of a slip-resistant polyethylene- or polypropylene-film top surface laminated to a layer of butyl- or SBS-modified asphalt adhesive, with release-paper backing; specifically designed to withstand high metal temperatures beneath metal roofing. Provide primer in accordance with underlayment manufacturer's written instructions.
 - 1. Low-Temperature Flexibility: ASTM D1970/D1970M; passes after testing at minus 20 deg F or lower.

2.4 MISCELLANEOUS MATERIALS

- A. Provide materials and types of fasteners, solder, protective coatings, sealants, and other miscellaneous items as required for complete sheet metal flashing and trim installation and as recommended by manufacturer of primary sheet metal or manufactured item unless otherwise indicated.

- B. Fasteners: Wood screws, annular threaded nails, self-tapping screws, self-locking rivets and bolts, and other suitable fasteners designed to withstand design loads and recommended by manufacturer of primary sheet metal or manufactured item.
1. General: Blind fasteners or self-drilling screws, gasketed, with hex-washer head.
 - a. Exposed Fasteners: Heads matching color of sheet metal using plastic caps or factory-applied coating. Provide metal-backed EPDM or PVC sealing washers under heads of exposed fasteners bearing on weather side of metal.
 - b. Blind Fasteners: High-strength aluminum or stainless steel rivets suitable for metal being fastened.
 - c. Spikes and Ferrules: Same material as gutter; with spike with ferrule matching internal gutter width.
 2. Fasteners for Stainless Steel Sheet: Series 300 stainless steel.
 3. Fasteners for Zinc-Coated (Galvanized) Steel Sheet: Series 300 stainless steel or hot-dip galvanized steel in accordance with ASTM A153/A153M or ASTM F2329/F2329M.
- C. Solder:
1. For Zinc-Coated (Galvanized) Steel: ASTM B32, Grade Sn50, 50 percent tin and 50 percent lead or Grade Sn60, 60 percent tin and 40 percent lead.
- D. Sealant Tape: Pressure-sensitive, 100 percent solids, polyisobutylene compound sealant tape with release-paper backing. Provide permanently elastic, nonsag, nontoxic, nonstaining tape 1/2 inch wide and 1/8 inch thick.
- E. Elastomeric Sealant: ASTM C920, elastomeric silicone polymer sealant; of type, grade, class, and use classifications required to seal joints in sheet metal flashing and trim and remain watertight.
- F. Butyl Sealant: ASTM C1311, single-component, solvent-release butyl rubber sealant; polyisobutylene plasticized; heavy bodied for hooked-type expansion joints with limited movement.
- G. Epoxy Seam Sealer: Two-part, noncorrosive, aluminum seam-cementing compound, recommended by aluminum manufacturer for exterior nonmoving joints, including riveted joints.
- H. Bituminous Coating: Cold-applied asphalt emulsion in accordance with ASTM D1187/D1187M.
- I. Reglets: Units of type, material, and profile required, formed to provide secure interlocking of separate reglet and counterflashing pieces, and compatible with flashing indicated with factory-mitered and -welded corners and junctions and with interlocking counterflashing on exterior face, of same metal as reglet.
1. Material: Stainless steel, 0.0188 inch thick.
 2. Surface-Mounted Type: Provide with slotted holes for fastening to substrate, with neoprene or other suitable weatherproofing washers, and with channel for sealant at top edge.

3. Concrete Type: Provide temporary closure tape to keep reglet free of concrete materials, special fasteners for attaching reglet to concrete forms, and guides to ensure alignment of reglet section ends.
4. Masonry Type: Provide with offset top flange for embedment in masonry mortar joint.
5. Accessories:
 - a. Flexible-Flashing Retainer: Provide resilient plastic or rubber accessory to secure flexible flashing in reglet where clearance does not permit use of standard metal counterflashing or where Drawings show reglet without metal counterflashing.
 - b. Counterflashing Wind-Restraint Clips: Provide clips to be installed before counterflashing to prevent wind uplift of counterflashing's lower edge.
6. Finish: With manufacturer's standard color coating.

2.5 FABRICATION, GENERAL

- A. Custom fabricate sheet metal flashing and trim to comply with details indicated and recommendations in cited sheet metal standard that apply to design, dimensions, geometry, metal thickness, and other characteristics of item required.
 1. Fabricate sheet metal flashing and trim in shop to greatest extent possible.
 2. Fabricate sheet metal flashing and trim in thickness or weight needed to comply with performance requirements, but not less than that specified for each application and metal.
 3. Verify shapes and dimensions of surfaces to be covered and obtain field measurements for accurate fit before shop fabrication.
 4. Form sheet metal flashing and trim to fit substrates without excessive oil-canning, buckling, and tool marks; true to line, levels, and slopes; and with exposed edges folded back to form hems.
 5. Conceal fasteners and expansion provisions where possible. Do not use exposed fasteners on faces exposed to view.
- B. Fabrication Tolerances:
 1. Fabricate sheet metal flashing and trim that is capable of installation to a tolerance of 1/4 inch in 20 feet on slope and location lines indicated on Drawings and within 1/8-inch offset of adjoining faces and of alignment of matching profiles.
 2. Fabricate sheet metal flashing and trim that is capable of installation to tolerances specified.
- C. Expansion Provisions: Form metal for thermal expansion of exposed flashing and trim.
 1. Form expansion joints of intermeshing hooked flanges, not less than 1 inch deep, filled with butyl sealant concealed within joints.
 2. Use lapped expansion joints only where indicated on Drawings.
- D. Sealant Joints: Where movable, nonexpansion-type joints are required, form metal in accordance with cited sheet metal standard to provide for proper installation of elastomeric sealant.

- E. Fabricate cleats and attachment devices from same material as accessory being anchored or from compatible, noncorrosive metal.
- F. Fabricate cleats and attachment devices of sizes as recommended by cited sheet metal standard and by FM Global Property Loss Prevention Data Sheet 1-49 for application, but not less than thickness of metal being secured.
- G. Seams:
 - 1. Fabricate nonmoving seams with flat-lock seams. Tin edges to be seamed, form seams, and solder.
 - 2. Fabricate nonmoving seams with flat-lock seams. Form seams and seal with elastomeric sealant unless otherwise recommended by sealant manufacturer for intended use. Rivet joints where necessary for strength.
 - 3. Seams for Aluminum: Fabricate nonmoving seams with flat-lock seams. Form seams and seal with epoxy seam sealer. Rivet joints where necessary for strength.

2.6 ROOF-DRAINAGE SHEET METAL FABRICATIONS

- A. Hanging Gutters:
 - 1. Fabricate to cross section required, complete with end pieces, outlet tubes, and other accessories as required.
 - 2. Fabricate in minimum 96-inch- long sections.
 - 3. Furnish flat-stock gutter brackets and flat-stock gutter spacers and straps fabricated from same metal as gutters, of size recommended by cited sheet metal standard, but with thickness not less than twice the gutter thickness.
 - 4. Fabricate expansion joints, expansion-joint covers, gutter bead reinforcing bars, and gutter accessories from same metal as gutters. Shop fabricate interior and exterior corners.
 - 5. Accessories: Continuous, removable leaf screen with sheet metal frame and hardware cloth screen.
 - 6. Gutters with Girth up to 15 Inches: Fabricate from the following materials:
 - a. Galvanized Steel: 0.022 inch thick.
 - 7. Gutters with Girth 16 to 20 Inches: Fabricate from the following materials:
 - a. Galvanized Steel: 0.028 inch thick.
 - 8. Gutters with Girth 21 to 25 Inches: Fabricate from the following materials:
 - a. Galvanized Steel: 0.034 inch thick.
 - 9. Gutters with Girth 26 to 30 Inches: Fabricate from the following materials:
 - a. Galvanized Steel: 0.040 inch thick.
 - 10. Gutters with Girth 31 to 35 Inches: Fabricate from the following materials:
 - a. Galvanized Steel: 0.052 inch thick.
- B. Downspouts: Fabricate rectangular downspouts to dimensions indicated on Drawings, complete with mitered elbows. Furnish with metal hangers from same material as downspouts and anchors. Shop fabricate elbows.
 - 1. Fabricate from the following materials:
 - a. Galvanized Steel: 0.022 inch thick.

- C. Parapet Scuppers: Fabricate scuppers to dimensions required, with closure flange trim to exterior, 4-inch- wide wall flanges to interior, and base extending 4 inches beyond cant or tapered strip into field of roof. Fasten gravel guard angles to base of scupper. Fabricate from the following materials:

- 1. Galvanized Steel: 0.028 inch thick.

2.7 LOW-SLOPE ROOF SHEET METAL FABRICATIONS

- A. Roof Edge Flashing (Gravel Stop): Fabricate in minimum 96-inch- long, but not exceeding 12-foot- long sections. Furnish with 6-inch- wide, joint cover plates. Shop fabricate interior and exterior corners.

- 1. Fabricate from the following materials:

- a. Galvanized Steel: 0.028 inch thick.

- B. Base Flashing: Shop fabricate interior and exterior corners. Fabricate from the following materials:

- 1. Galvanized Steel: 0.028 inch thick.

- 2. Aluminum-Zinc Alloy-Coated Steel: 0.028 inch thick.

- C. Counterflashing: Shop fabricate interior and exterior corners. Fabricate from the following materials:

- 1. Galvanized Steel: 0.022 inch thick.

- 2. Aluminum-Zinc Alloy-Coated Steel: 0.022 inch thick.

- D. Roof-Penetration Flashing: Fabricate from the following materials:

- 1. Galvanized Steel: 0.028 inch thick.

- 2. Aluminum-Zinc Alloy-Coated Steel: 0.028 inch thick.

- E. Roof-Drain Flashing: Fabricate from the following materials:

- 1. Stainless Steel: 0.0156 inch thick.

2.8 WALL SHEET METAL FABRICATIONS

- A. Through-Wall Flashing: Fabricate continuous flashings in minimum 96-inch- long, but not exceeding 12-foot- long, sections, under copings, and at shelf angles. Fabricate discontinuous lintel, sill, and similar flashings to extend 6 inches beyond each side of wall openings; and form with 2-inch- high, end dams. Fabricate from the following materials:

- 1. Stainless Steel: 0.0156 inch thick.

- B. Opening Flashings in Frame Construction: Fabricate head, sill, jamb, and similar flashings to extend 4 inches beyond wall openings. Form head and sill flashing with 2-inch- high, end dams. Fabricate from the following materials:

- 1. Galvanized Steel: 0.022 inch thick.

- 2. Aluminum-Zinc Alloy-Coated Steel: 0.022 inch thick.

C. Wall Expansion-Joint Cover: Fabricate from the following materials:

1. Galvanized Steel: 0.028 inch thick.
2. Aluminum-Zinc Alloy-Coated Steel: 0.028 inch thick.

PART 3 - EXECUTION

3.1 INSTALLATION OF UNDERLAYMENT

A. Felt Underlayment: Install felt underlayment, wrinkle free, using adhesive to minimize use of mechanical fasteners under sheet metal flashing and trim.

1. Install in shingle fashion to shed water.
2. Lap joints not less than 2 inches.

B. Synthetic Underlayment: Install synthetic underlayment, wrinkle free, in accordance with manufacturers' written instructions, and using adhesive where possible to minimize use of mechanical fasteners under sheet metal.

1. Lap horizontal joints not less than 4 inches.
2. Lap end joints not less than 12 inches.

C. Self-Adhering, High-Temperature Sheet Underlayment:

1. Install self-adhering, high-temperature sheet underlayment; wrinkle free.
2. Prime substrate if recommended by underlayment manufacturer.
3. Comply with temperature restrictions of underlayment manufacturer for installation; use primer for installing underlayment at low temperatures.
4. Apply in shingle fashion to shed water, with end laps of not less than 6 inches staggered 24 inches between courses.
5. Overlap side edges not less than 3-1/2 inches. Roll laps and edges with roller.
6. Roll laps and edges with roller.
7. Cover underlayment within 14 days.

3.2 INSTALLATION, GENERAL

A. Install sheet metal flashing and trim to comply with details indicated and recommendations of cited sheet metal standard that apply to installation characteristics required unless otherwise indicated on Drawings.

1. Install fasteners, protective coatings, separators, sealants, and other miscellaneous items as required to complete sheet metal flashing and trim system.
2. Install sheet metal flashing and trim true to line, levels, and slopes. Provide uniform, neat seams with minimum exposure of sealant.
3. Anchor sheet metal flashing and trim and other components of the Work securely in place, with provisions for thermal and structural movement.
4. Install sheet metal flashing and trim to fit substrates and to result in watertight performance.
5. Install continuous cleats with fasteners spaced not more than 12 inches o.c.
6. Space individual cleats not more than 12 inches apart. Attach each cleat with at least two fasteners. Bend tabs over fasteners.

7. Install exposed sheet metal flashing and trim with limited oil-canning, and free of buckling and tool marks.
 8. Do not field cut sheet metal flashing and trim by torch.
- B. Metal Protection: Where dissimilar metals contact each other, or where metal contacts pressure-treated wood or other corrosive substrates, protect against galvanic action or corrosion by painting contact surfaces with bituminous coating or by other permanent separation as recommended by sheet metal manufacturer or cited sheet metal standard.
1. Coat concealed side of uncoated-aluminum and stainless steel sheet metal flashing and trim with bituminous coating where flashing and trim contact wood, ferrous metal, or cementitious construction.
 2. Underlayment: Where installing sheet metal flashing and trim directly on cementitious or wood substrates, install underlayment and cover with slip sheet.
- C. Expansion Provisions: Provide for thermal expansion of exposed flashing and trim.
1. Space movement joints at maximum of 10 feet with no joints within 24 inches of corner or intersection.
 2. Form expansion joints of intermeshing hooked flanges, not less than 1 inch deep, filled with sealant concealed within joints.
 3. Use lapped expansion joints only where indicated on Drawings.
- D. Fasteners: Use fastener sizes that penetrate substrate not less than recommended by fastener manufacturer to achieve maximum pull-out resistance.
- E. Conceal fasteners and expansion provisions where possible in exposed work and locate to minimize possibility of leakage. Cover and seal fasteners and anchors as required for a tight installation.
- F. Seal joints as required for watertight construction.
1. Use sealant-filled joints unless otherwise indicated.
 - a. Embed hooked flanges of joint members not less than 1 inch into sealant.
 - b. Form joints to completely conceal sealant.
 - c. When ambient temperature at time of installation is between 40 and 70 deg F, set joint members for 50 percent movement each way.
 - d. Adjust setting proportionately for installation at higher ambient temperatures.
 - 1) Do not install sealant-type joints at temperatures below 40 deg F.
 2. Prepare joints and apply sealants to comply with requirements in Section 079200 "Joint Sealants."
- G. Soldered Joints: Clean surfaces to be soldered, removing oils and foreign matter.
1. Pre-tin edges of sheets with solder to width of 1-1/2 inches; however, reduce pre-tinning where pre-tinned surface would show in completed Work.
 2. Do not solder metallic-coated steel and aluminum sheet.
 3. Do not pre-tin zinc-tin alloy-coated copper.
 4. Do not use torches for soldering.
 5. Heat surfaces to receive solder, and flow solder into joint.
 - a. Fill joint completely.

- b. Completely remove flux and spatter from exposed surfaces.
- 6. Stainless Steel Soldering:
 - a. Tin edges of uncoated sheets, using solder for stainless steel and acid flux.
 - b. Promptly remove acid-flux residue from metal after tinning and soldering.
 - c. Comply with solder manufacturer's recommended methods for cleaning and neutralization.
- 7. Copper Soldering: Tin edges of uncoated sheets, using solder for copper.
- H. Rivets: Rivet joints in uncoated aluminum where necessary for strength.

3.3 INSTALLATION OF ROOF-DRAINAGE SYSTEM

- A. Install sheet metal roof-drainage items to produce complete roof-drainage system in accordance with cited sheet metal standard unless otherwise indicated. Coordinate installation of roof perimeter flashing with installation of roof-drainage system.
- B. Hanging Gutters:
 - 1. Join sections with riveted and soldered joints or joints sealed with sealant.
 - 2. Provide for thermal expansion.
 - 3. Attach gutters at eave or fascia to firmly anchor them in position.
 - 4. Provide end closures and seal watertight with sealant.
 - 5. Slope to downspouts.
 - 6. Install gutter with expansion joints at locations indicated on Drawings, but not exceeding, 50 feet apart. Install expansion-joint caps.
 - 7. Install continuous gutter screens on gutters with noncorrosive fasteners, hinged to swing open for cleaning gutters.
- C. Downspouts:
 - 1. Join sections with 1-1/2-inch telescoping joints.
 - 2. Provide hangers with fasteners designed to hold downspouts securely to walls.
 - 3. Locate hangers at top and bottom and at approximately 60 inches o.c.
 - 4. Provide elbows at base of downspout to direct water away from building.
 - 5. Connect downspouts to underground drainage system.
- D. Parapet Scuppers:
 - 1. Continuously support scupper, set to correct elevation, and seal flanges to interior wall face, over cants or tapered edge strips, and under roofing membrane.
 - 2. Anchor scupper closure trim flange to exterior wall and solder or seal with elastomeric sealant to scupper.
 - 3. Loosely lock front edge of scupper with conductor head.
 - 4. Solder or seal with elastomeric sealant exterior wall scupper flanges into back of conductor head.
- E. Conductor Heads: Anchor securely to wall, with elevation of conductor head rim at minimum of 1 inch below scupper or gutter discharge.
- F. Expansion-Joint Covers: Install expansion-joint covers at locations and of configuration indicated on Drawings. Lap joints minimum of 4 inches in direction of water flow.

3.4 INSTALLATION OF ROOF FLASHINGS

- A. Install sheet metal flashing and trim to comply with performance requirements, sheet metal manufacturer's written installation instructions, and cited sheet metal standard.
 - 1. Provide concealed fasteners where possible, and set units true to line, levels, and slopes.
 - 2. Install work with laps, joints, and seams that are permanently watertight and weather resistant.
- B. Roof Edge Flashing:
 - 1. Install roof edge flashings in accordance with ANSI/SPRI/FM 4435/ES-1.
 - 2. Anchor to resist uplift and outward forces in accordance with recommendations in cited sheet metal standard unless otherwise indicated. Interlock bottom edge of roof edge flashing with continuous cleat anchored to substrate at staggered 3-inch centers.
 - 3. Anchor to resist uplift and outward forces in accordance with recommendations in FM Global Property Loss Prevention Data Sheet 1-49 for FM Approvals' listing for required windstorm classification.
- C. Copings:
 - 1. Install roof edge flashings in accordance with ANSI/SPRI/FM 4435/ES-1.
 - 2. Anchor to resist uplift and outward forces in accordance with recommendations in cited sheet metal standard unless otherwise indicated.
 - a. Interlock exterior bottom edge of coping with continuous cleat anchored to substrate at 24-inch centers.
 - b. Anchor interior leg of coping with washers and screw fasteners through slotted holes at 24-inch centers.
 - 3. Anchor to resist uplift and outward forces in accordance with recommendations in FM Global Property Loss Prevention Data Sheet 1-49 for specified FM Approvals' listing for required windstorm classification.
- D. Pipe or Post Counterflashing: Install counterflashing umbrella with close-fitting collar with top edge flared for elastomeric sealant, extending minimum of 4 inches over base flashing. Install stainless steel draw band and tighten.
- E. Counterflashing: Coordinate installation of counterflashing with installation of base flashing.
 - 1. Insert counterflashing in reglets or receivers and fit tightly to base flashing.
 - 2. Extend counterflashing 4 inches over base flashing.
 - 3. Lap counterflashing joints minimum of 4 inches.
- F. Roof-Penetration Flashing: Coordinate installation of roof-penetration flashing with installation of roofing and other items penetrating roof. Seal with elastomeric sealant and clamp flashing to pipes that penetrate roof.

3.5 INSTALLATION OF WALL FLASHINGS

- A. Install sheet metal wall flashing to intercept and exclude penetrating moisture in accordance with cited sheet metal standard unless otherwise indicated. Coordinate installation of wall flashing with installation of wall-opening components such as windows, doors, and louvers.
- B. Opening Flashings in Frame Construction: Install continuous head, sill, jamb, and similar flashings to extend 4 inches beyond wall openings.

3.6 INSTALLATION TOLERANCES

- A. Installation Tolerances: Shim and align sheet metal flashing and trim within installed tolerance of 1/4 inch in 20 feet on slope and location lines indicated on Drawings and within 1/8-inch offset of adjoining faces and of alignment of matching profiles.

3.7 CLEANING

- A. Clean exposed metal surfaces of substances that interfere with uniform oxidation and weathering.
- B. Clean and neutralize flux materials. Clean off excess solder.
- C. Clean off excess sealants.

3.8 PROTECTION

- A. Remove temporary protective coverings and strippable films as sheet metal flashing and trim are installed unless otherwise indicated in manufacturer's written installation instructions.
- B. Replace sheet metal flashing and trim that have been damaged or that have deteriorated beyond successful repair by finish touchup or similar minor repair procedures, as determined by Architect.

END OF SECTION 076200

SECTION 077100 - ROOF SPECIALTIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification Sections, apply to work of this section.

1.2 SUMMARY

A. Section Includes:

1. Roof-edge specialties.
2. Roof-edge drainage systems.
3. Reglets and counterflashings.

B. Related Requirements.

1. Section 033000 "Cast-in-Place Concrete" for installing embedded reglets.
2. Section 042000 "Unit Masonry" for installing embedded reglets and for masonry through-wall flashing with receiver for counterflashing.
3. Section 055000 "Metal Fabrications" for downspout guards and downspout boots.
4. Section 061000 "Rough Carpentry" for wood nailers, curbs, and blocking.
5. Section 076200 "Sheet Metal Flashing and Trim" for custom- and site-fabricated, sheet metal flashing and trim.
6. Section 077200 "Roof Accessories" for manufactured roof curbs, equipment supports, roof hatches, vents, and other manufactured roof accessory units.
7. Section 077253 "Snow Guards" for prefabricated devices designed to hold snow on the roof surface, allowing it to melt and drain off slowly.
8. Section 079200 "Joint Sealants" for field-applied sealants between roof specialties and adjacent materials.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.

1.4 INFORMATIONAL SUBMITTALS

- A. Product Test Reports: For tests performed by a qualified testing agency.
- B. Product Certificates: For each type of roof specialty that is ANSI/SPRI/FM 4435/ES-1 tested.

1.5 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For roofing specialties to include in maintenance manuals.

1.6 QUALITY ASSURANCE

- A. Manufacturer Qualifications: A qualified manufacturer offering products that are FM Approvals listed for specified class.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Do not store roof specialties in contact with other materials that might cause staining, denting, or other surface damage. Store roof specialties away from uncured concrete and masonry.
- B. Protect strippable protective covering on roof specialties from exposure to sunlight and high humidity, except to extent necessary for the period of roof-specialty installation.

1.8 FIELD CONDITIONS

- A. Field Measurements: Verify profiles and tolerances of roof-specialty substrates by field measurements before fabrication, and indicate measurements on Shop Drawings.

1.9 COORDINATION

- A. Coordinate roof specialties with roofing system, exterior wall system, air barrier, flashing, trim, and construction of parapets, roof deck, roof and wall panels, and other adjoining work to provide a leakproof, weathertight, secure, and noncorrosive installation.
 - 1. Performance Coordination: Coordinate with the Work of roofing and exterior wall Sections to ensure that roof specialties provided under the Work of this Section meet or exceed specified roofing and exterior wall design performance requirements.
- B. Confirm and coordinate compatibility of materials and comply with warranty requirements of roofing system manufacturer.
- C. Coordinate roof specialties layout and seams with sizes and locations of joints and seams in adjacent materials.

1.10 WARRANTY

- A. Special Warranty on Painted Finishes: Manufacturer agrees to repair finish or replace roof specialties that show evidence of deterioration of factory-applied finishes within specified warranty period.
 - 1. Fluoropolymer Finish: Deterioration includes, but is not limited to, the following:
 - a. Color fading more than 5 Delta E units when tested in accordance with ASTM D2244.
 - b. Chalking in excess of a No. 8 rating when tested in accordance with ASTM D4214.

- c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.
2. Finish Warranty Period: 20 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. FM Approvals' Listing: Manufacture and install **roof-edge specialties** that are listed in FM Approvals' "Approval Guide" and approved for windstorm classification, Class as indicated on the Drawings. Identify materials with FM Approvals' markings.
- B. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes to prevent buckling, opening of joints, hole elongation, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects. Provide clips that resist rotation and avoid shear stress resulting from thermal movements. Base calculations on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.
 1. Temperature Change (Range): 120 deg F, ambient; 180 deg F, material surfaces.

2.2 ROOF-EDGE SPECIALTIES

- A. Roof-Edge Fascia: Manufactured, two-piece, roof-edge fascia consisting of snap-on metal fascia cover in section lengths not exceeding 12 feet and a continuous metal receiver with integral drip-edge cleat to engage fascia cover and secure single-ply roof membrane. Provide matching corner units.
 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. ATAS International, Inc.
 - b. Berridge Manufacturing Company.
 - c. Drexel Metals.
 - d. Metal-Era, Inc.
 2. Metallic-Coated Steel Sheet Fascia Covers: Zinc-coated (galvanized) steel, nominal 0.028-inch thickness thickness as required to meet performance requirements.
 - a. Surface: Smooth, flat finish.
 - b. Finish: Three-coat fluoropolymer.
 - c. Color: As selected by A/E from manufacturer's full range.
 3. Corners: Factory mitered and mechanically clinched and sealed watertight.
 4. Splice Plates: Concealed, of same material, finish, and shape as fascia cover.
 5. Receiver: Manufacturer's standard material and thickness.
 6. Fascia Accessories: Fascia extenders with continuous hold-down cleats Overflow scuppers Overflow scuppers with perforated screens Spillover scuppers.

2.3 ROOF-EDGE DRAINAGE SYSTEMS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
1. Architectural Products Company.
 2. Cheney Flashing Company.
 3. Drexel Metals.
 4. Metal-Era, Inc.
- B. Gutters: Manufactured in uniform section lengths not exceeding 12 feet, with matching corner units, ends, outlet tubes, and other accessories. Elevate back edge at least 1 inch above front edge. Furnish flat-stock gutter straps, gutter brackets, expansion joints, and expansion-joint covers fabricated from same metal as gutters.
1. Zinc-Coated Steel: Nominal 0.034-inch thickness.
 2. Gutter Profile: Style A in accordance with SMACNA's "Architectural Sheet Metal Manual."
 3. Corners: Factory mitered and mechanically clinched and sealed watertight.
 4. Gutter Supports: Gutter brackets Straps Spikes and ferrules Manufacturer's standard supports as selected by A/E with finish matching the gutters.
 5. Gutter Accessories: Continuous screened leaf guard with sheet metal frame, bronze wire ball downspout strainer, and flat ends.
- C. Downspouts: Plain rectangular complete with mitered elbows, manufactured from the following exposed metal. Furnish with metal hangers, from same material as downspouts, and anchors.
1. Formed Aluminum: 0.032 inch thick.
- D. Zinc-Coated Steel Finish: Three-coat fluoropolymer.
1. Color: As selected by A/E from manufacturer's full range.
- E. Aluminum Finish: Three-coat fluoropolymer.
1. Color: As selected by A/E from manufacturer's full range.

2.4 REGLETS AND COUNTERFLASHINGS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
1. Berridge Manufacturing Company.
 2. Drexel Metals.
 3. Fry Reglet Corporation.
 4. Heckmann Building Products, Inc.
 5. Keystone Flashing Company, Inc.
 6. Metal-Era, Inc.

- B. Reglets: Manufactured units formed to provide secure interlocking of separate reglet and counterflashing pieces, from the following exposed metal:
 - 1. Stainless Steel: 0.0188 inch thick.
 - 2. Corners: Factory mitered and mechanically clinched and sealed watertight.
 - 3. Multiuse Type, Embedded: For multiuse embedment in cast-in-place concrete masonry mortar joints.
- C. Counterflashings: Manufactured units of heights to overlap top edges of base flashings by 4 inches and in lengths not exceeding 12 feet designed to snap into reglets or through-wall-flashing receiver and compress against base flashings with joints lapped, from the following exposed metal:
 - 1. Zinc-Coated Steel: Nominal 0.022-inch thickness.
- D. Accessories:
 - 1. Flexible-Flashing Retainer: Provide resilient plastic or rubber accessory to secure flexible flashing in reglet where clearance does not permit use of standard metal counterflashing or where reglet is provided separate from metal counterflashing.
 - 2. Counterflashing Wind-Restraint Clips: Provide clips to be installed before counterflashing to prevent wind uplift of counterflashing lower edge.
- E. Zinc-Coated Steel Finish: Three-coat fluoropolymer.
 - 1. Color: As selected by A/E from manufacturer's full range.
- F. Aluminum Finish: Three-coat fluoropolymer.
 - 1. Color: As selected by A/E from manufacturer's full range.
- G. Stainless Steel Finish: ASTM A480/A480M No. 2B (bright, cold rolled, unpolished).

2.5 MATERIALS

- A. Zinc-Coated (Galvanized) Steel Sheet: ASTM A653/A653M, G90 coating designation.
- B. Aluminum Sheet: ASTM B209, alloy as standard with manufacturer for finish required, with temper to suit forming operations and performance required.
- C. Stainless Steel Sheet: ASTM A240/A240M or ASTM A666, Type 304.
- D. Copper Sheet: ASTM B370, cold-rolled copper sheet, H00 or H01 temper.

2.6 MISCELLANEOUS MATERIALS

- A. Fasteners: Manufacturer's recommended fasteners, suitable for application and designed to meet performance requirements. Furnish the following unless otherwise indicated:
 - 1. Exposed Penetrating Fasteners: Gasketed screws with hex washer heads matching color of sheet metal.
 - 2. Fasteners for Copper Sheet: Copper, hardware bronze, or passivated Series 300 stainless steel.

3. Fasteners for Aluminum: Aluminum or Series 300 stainless steel.
 4. Fasteners for Stainless Steel Sheet: Series 300 stainless steel.
 5. Fasteners for Zinc-Coated (Galvanized) Steel Sheet: Series 300 stainless steel or hot-dip zinc-coated steel in accordance with ASTM A153/A153M or ASTM F2329.
- B. Elastomeric Sealant: ASTM C920, elastomeric polymer sealant of type, grade, class, and use classifications required by roofing-specialty manufacturer for each application.
- C. Bituminous Coating: Cold-applied asphalt emulsion complying with ASTM D1187/D1187M.
- D. Asphalt Roofing Cement: ASTM D4586, asbestos free, of consistency required for application.

2.7 FINISHES

- A. Coil-Coated Galvanized-Steel Sheet Finishes:
1. High-Performance Organic Finish: Prepare, pretreat, and apply coating to exposed metal surfaces to comply with ASTM A755/A755M and coating and resin manufacturers' written instructions.
 - a. Three-Coat Fluoropolymer: AAMA 621. Fluoropolymer finish containing not less than 70 percent polyvinylidene fluoride (PVDF) resin by weight in both color coat and clear topcoat.

PART 3 - EXECUTION

3.1 INSTALLATION OF UNDERLAYMENT

- A. Felt Underlayment: Install felt underlayment, wrinkle free, using adhesive to minimize use of mechanical fasteners under sheet metal flashing and trim.
1. Install in shingle fashion to shed water.
 2. Lap joints not less than 2 inches.

3.2 INSTALLATION, GENERAL

- A. Install roof specialties in accordance with manufacturer's written instructions. Anchor roof specialties securely in place, with provisions for thermal and structural movement. Use fasteners, solder, protective coatings, separators, underlayments, sealants, and other miscellaneous items as required to complete roof-specialty systems.
1. Install roof specialties level, plumb, true to line and elevation; with limited oil-canning and without warping, jogs in alignment, buckling, or tool marks.
 2. Provide uniform, neat seams with minimum exposure of solder and sealant.
 3. Install roof specialties to fit substrates and to result in weathertight performance. Verify shapes and dimensions of surfaces to be covered before manufacture.
 4. Torch cutting of roof specialties is not permitted.

5. Do not use graphite pencils to mark metal surfaces.
- B. Metal Protection: Protect metals against galvanic action by separating dissimilar metals from contact with each other or with corrosive substrates by painting contact surfaces with bituminous coating or by other permanent separation as recommended by manufacturer.
 1. Coat concealed side of uncoated aluminum and stainless steel roof specialties with bituminous coating where in contact with wood, ferrous metal, or cementitious construction.
 2. Bed flanges in thick coat of asphalt roofing cement where required by manufacturers of roof specialties for waterproof performance.
 - C. Expansion Provisions: Allow for thermal expansion of exposed roof specialties.
 1. Space movement joints at a maximum of 12 feet with no joints within 18 inches of corners or intersections unless otherwise indicated on Drawings.
 2. When ambient temperature at time of installation is between 40 and 70 deg F, set joint members for 50 percent movement each way. Adjust setting proportionately for installation at higher ambient temperatures.
 - D. Fastener Sizes: Use fasteners of sizes that penetrate wood blocking or sheathing not less than 1-1/4 inches for nails and not less than 3/4 inch for wood screws.
 - E. Seal concealed joints with butyl sealant as required by roofing-specialty manufacturer.
 - F. Seal joints as required for weathertight construction. Place sealant to be completely concealed in joint. Do not install sealants at temperatures below 40 deg F.
 - G. Soldered Joints: Clean surfaces to be soldered, removing oils and foreign matter. Pre-tin edges of sheets to be soldered to a width of 1-1/2 inches; however, reduce pre-tinning where pre-tinned surface would show in completed Work. Tin edges of uncoated copper sheets using solder for copper. Do not use torches for soldering. Heat surfaces to receive solder and flow solder into joint. Fill joint completely. Completely remove flux and spatter from exposed surfaces.

3.3 INSTALLATION OF ROOF-EDGE SPECIALITIES

- A. Install cleats, cants, and other anchoring and attachment accessories and devices with concealed fasteners.
- B. Anchor roof edgings with manufacturer's required devices, fasteners, and fastener spacing to meet performance requirements.

3.4 INSTALLATION OF ROOF-EDGE DRAINAGE SYSTEMS

- A. Install components to produce a complete roof-edge drainage system in accordance with manufacturer's written instructions. Coordinate installation of roof perimeter flashing with installation of roof-edge drainage system.

- B. Gutters: Join and seal gutter lengths. Allow for thermal expansion. Attach gutters to firmly anchored gutter supports spaced not more than 24 inches apart. Attach ends with rivets and seal with sealant to make watertight. Slope to downspouts.
 - 1. Install gutter with expansion joints at locations indicated but not exceeding 50 feet apart. Install expansion-joint caps.
 - 2. Install continuous leaf guards on gutters with noncorrosive fasteners, hinged to swing open for cleaning gutters.
- C. Downspouts: Join sections with manufacturer's standard telescoping joints. Provide hangers with fasteners designed to hold downspouts securely to walls and 1 inch away from walls; locate fasteners at top and bottom and at approximately 60 inches o.c.
 - 1. Provide elbows at base of downspouts at grade to direct water away from building.
 - 2. Connect downspouts to underground drainage system indicated.
- D. Parapet Scuppers: Install scuppers through parapet where indicated. Continuously support scupper, set to correct elevation, and seal flanges to interior wall face, over cants or tapered edge strips, and under roofing membrane.
- E. Conductor Heads: Anchor securely to wall with elevation of conductor top edge 1 inch below scupper discharge.

3.5 INSTALLATION OF REGLETS AND COUNTERFLASHINGS

- A. Embedded Reglets: See Section 033000 "Cast-in-Place Concrete" and Section 042000 "Unit Masonry" for installation of reglets.
- B. Surface-Mounted Reglets: Install reglets to receive flashings where flashing without embedded reglets is indicated on Drawings. Install at height so that inserted counterflashings overlap 4 inches over top edge of base flashings.
- C. Counterflashings: Insert counterflashings into reglets or other indicated receivers; ensure that counterflashings overlap 4 inches over top edge of base flashings. Lap counterflashing joints a minimum of 4 inches and bed with butyl sealant. Fit counterflashings tightly to base flashings.

3.6 CLEANING AND PROTECTION

- A. Clean exposed metal surfaces of substances that interfere with uniform oxidation and weathering.
- B. Clean and neutralize flux materials. Clean off excess solder and sealants.
- C. Remove temporary protective coverings and strippable films as roof specialties are installed.

END OF SECTION 077100

SECTION 077200 - ROOF ACCESSORIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification Sections, apply to work of this section.

1.2 SUMMARY

- A. Section Includes: Manufactured units for the following applications:

1. Roof curbs.
2. Equipment supports.
3. Roof hatches.
4. Heat and smoke vents.
5. Gravity ventilators.
6. Pipe and duct supports.
7. Pipe portals.
8. Preformed flashing sleeves.
9. Roof walkways.
10. Underlayment.
11. Miscellaneous materials.

- B. Related Requirements:

1. Section 055000 "Metal Fabrications" for metal vertical ladders, ships' ladders, and stairs for access to roof hatches.
2. Section 061000 "Rough Carpentry" for roof cants, nailers, blocking, and other pressure-preservative-treated wood.
3. Section 077100 "Roof Specialties" for manufactured copings, roof-edge specialties, roof-edge drainage systems, reglets, and counterflashing.
4. Section 077253 "Snow Guards" for prefabricated devices designed to hold snow on the roof surface, allowing it to melt and drain off slowly.
5. Section 079200 "Joint Sealants" for field-applied sealants between roof accessories and adjacent materials.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of roof accessory.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.

- B. Samples for Verification: Include Samples of each type of roof accessory to verify finish and color selection, in manufacturer's standard sizes.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For roof accessories.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Do not store roof accessories in contact with other materials that might cause staining, denting, or other surface damage. Store roof accessories in accordance with manufacturer's instructions.
- B. Store materials off ground in dry location and in accordance with manufacturer's instructions in well-ventilated area.
- C. Store and protect roof accessories from nicks, scratches, and blemishes.

1.6 FIELD CONDITIONS

- A. Field Measurements: Verify profiles and tolerances of roof-accessory substrates by field measurements before fabrication, and indicate measurements on Shop Drawings.

1.7 COORDINATION

- A. Coordinate layout and installation of roof accessories with roofing membrane and base flashing and interfacing and adjoining construction to provide a leakproof, weathertight, secure, and noncorrosive installation.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. General Performance: Roof accessories to withstand exposure to weather and resist thermally induced movement without failure, rattling, leaking, or fastener disengagement due to defective manufacture, fabrication, installation, or other defects in construction.
- B. Wind-Restraint Performance: **As indicated on Drawings.**

2.2 METAL MATERIALS

- A. Metallic-Coated Steel Sheet: Zinc-coated (galvanized) steel sheer complying with minimum ASTM A653/A653M, G90 coating designation or aluminum-zinc alloy-coated steel sheet complying with minimum ASTM A792/A792M, Class AZ50 coating designation; structural quality.
 1. Mill-Phosphatized Finish: Manufacturer's standard for field painting.
 2. Factory Prime Coating: Where field painting is indicated, apply pretreatment and white or light-colored, factory-applied, baked-on epoxy primer coat, with a minimum dry film thickness of 0.2 mil.
 3. Powder Coat Finish: After cleaning and pretreating, apply manufacturer's

standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat to a minimum dry film thickness of 2 mils.

4. Concealed Finish: Pretreat with manufacturer's standard white or light-colored acrylic or polyester-backer finish consisting of prime coat and wash coat, with a minimum total dry film thickness of 0.5 mil.

B. Stainless Steel Sheet and Shapes: ASTM A240/A240M or ASTM A666, Type 304.

C. Steel Shapes: ASTM A36/A36M, hot-dip galvanized in accordance with ASTM A123/A123M unless otherwise indicated.

2.3 UNDERLAYMENT

A. Felt: ASTM D226/D226M, Type II (No. 30), asphalt-saturated organic felt, nonperforated.

2.4 MISCELLANEOUS MATERIALS

A. Provide materials and types of fasteners, protective coatings, sealants, and other miscellaneous items required by manufacturer for a complete installation.

B. Polyisocyanurate Board Insulation: ASTM C1289, thickness and thermal resistivity as indicated.

C. Wood Nailers: Softwood lumber, pressure treated with waterborne preservatives for aboveground use, acceptable to authorities having jurisdiction, containing no arsenic or chromium, and complying with AWPA C2; not less than 1-1/2 inches thick.

D. Fasteners: Roof accessory manufacturer's recommended fasteners, designed to comply with performance requirements, suitable for application and metals being fastened. Match finish of exposed fasteners with finish of material being fastened. Provide nonremovable fastener heads to exterior exposed fasteners. Furnish the following unless otherwise indicated:

1. Fasteners for Metallic-Coated Steel Sheet: Series 300 stainless steel or hot-dip zinc-coated steel in accordance with ASTM A153/A153M or ASTM F2329/F2329M.
2. Fasteners for Aluminum Sheet: Aluminum or Series 300 stainless steel.
3. Fasteners for Stainless Steel Sheet: Series 300 stainless steel.

E. Gaskets: Manufacturer's standard tubular or fingered design of neoprene, EPDM, PVC, or silicone or a flat design of foam rubber, sponge neoprene, or cork.

F. Elastomeric Sealant: ASTM C920, elastomeric silicone polymer sealant as recommended by roof accessory manufacturer for installation indicated; low modulus; of type, grade, class, and use classifications required to seal joints and remain watertight.

G. Butyl Sealant: ASTM C1311, single-component, solvent-release butyl rubber sealant; polyisobutylene plasticized; heavy bodied for expansion joints with limited movement.

- H. Bituminous Coating: Cold-applied asphalt emulsion complying with ASTM D1187/D1187M.
- I. Asphalt Roofing Cement: ASTM D4586/D4586M, asbestos free, of consistency required for application.

2.5 GENERAL FINISH REQUIREMENTS

- A. Comply with NAAMM/NOMMA AMP 500, "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
- B. Protect mechanical and painted finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- C. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, to verify actual locations, dimensions, and other conditions affecting performance of the Work.
- B. Verify that substrate is sound, dry, smooth, clean, sloped for drainage, and securely anchored.
- C. Verify dimensions of roof openings for roof accessories.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF UNDERLAYMENT

- A. Felt Underlayment: Install felt underlayment, wrinkle free, using adhesive to minimize use of mechanical fasteners under sheet metal flashing and trim.
 - 1. Install in shingle fashion to shed water.
 - 2. Lap joints not less than 2 inches.

3.3 INSTALLATION, GENERAL

- A. Install roof accessories in accordance with manufacturer's written instructions.
 - 1. Install roof accessories level; plumb; true to line and elevation; and without warping, jogs in alignment, buckling, or tool marks.
 - 2. Anchor roof accessories securely in place so they are capable of resisting indicated loads.
 - 3. Use fasteners, separators, sealants, and other miscellaneous items as required to complete installation of roof accessories and fit them to substrates.

4. Install roof accessories to resist exposure to weather without failing, rattling, leaking, or loosening of fasteners and seals.
- B. Metal Protection: Protect metals against galvanic action by separating dissimilar metals from contact with each other or with corrosive substrates by painting contact surfaces with bituminous coating or by other permanent separation as recommended in writing by manufacturer's written installation instructions.
1. Coat concealed side of uncoated aluminum and stainless steel roof accessories with bituminous coating where in contact with wood, ferrous metal, or cementitious construction.
 2. Bed flanges in thick coat of asphalt roofing cement where required by manufacturers of roof accessories for waterproof performance.

3.4 INSTALLATION OF ROOF ACCESSORIES

- A. Roof Curb: Install each roof curb so top surface is level.
- B. Equipment Support: Install equipment supports so top surfaces are level with each other.
- C. Roof-Hatch:
1. Verify that roof hatch operates properly. Clean, lubricate, and adjust operating mechanism and hardware.
 2. Attach safety railing system to roof-hatch curb.
 3. Attach ladder-assist post in accordance with manufacturer's written instructions.
- D. Heat and Smoke Vent:
1. Install heat and smoke vent so top perimeter surfaces are level.
 2. Install and test heat and smoke vents and their components for proper operation in accordance with NFPA 204.
- E. Gravity Ventilator: Verify that gravity ventilators operate properly and have unrestricted airflow. Clean, lubricate, and adjust operating mechanisms.
- F. Pipe and Duct Support: Comply with MSS SP-58. Install supports and attachments as required to properly support piping. Arrange for grouping of parallel runs of horizontal piping, and support together.
1. Pipes of Various Sizes: Space supports for smallest pipe size or install intermediate supports for smaller-diameter pipes as specified for individual pipe hangers.
- G. Preformed Flashing-Sleeve and Flashing-Pipe Portal: Secure flashing sleeve to roof membrane in accordance with flashing-sleeve manufacturer's written instructions; flash sleeve flange to surrounding roof membrane in accordance with roof membrane manufacturer's instructions.

3.5 CLEANING AND PROTECTION

- A. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing in accordance with ASTM A780/A780M.
- B. Touch up factory-primed surfaces with compatible primer ready for field painting in accordance with Section 099113 "Exterior Painting."
- C. On completion of installation, clean exposed surfaces in accordance with manufacturer's written instructions. Clean off excess sealants.
- D. Remove temporary protective coverings and strippable films as roof accessories are installed. On completion of installation, clean finished surfaces, including removing unused fasteners, metal filings, pop rivet stems, and pieces of flashing. Maintain roof accessories in a clean condition during construction.
- E. Replace roof accessories that have been damaged or that cannot be successfully repaired by finish touchup or similar minor repair procedures, as determined by A/E.

END OF SECTION 077200

SECTION 079200 - JOINT SEALANTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification Sections, apply to work of this section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Nonstaining silicone joint sealants.

1.3 ACTION SUBMITTALS

- A. Product data.
- B. Samples: Manufacturer's standard color charts consisting of strips of cured sealants showing the full range of colors available for each product exposed to view.

1.4 INFORMATIONAL SUBMITTALS

- A. Field Quality-Control Reports: For field-adhesion-test reports, for each sealant application tested.

1.5 CLOSEOUT SUBMITTALS

- A. Warranty Documentation:
 - 1. Manufacturers' special warranties.
 - 2. Installer's special warranties.

1.6 QUALITY ASSURANCE

- A. Installer Qualifications: Authorized representative who is trained and approved by manufacturer.
- B. Testing Agency Qualifications: Qualified in accordance with ASTM C1021 to conduct the testing indicated.

1.7 WARRANTY

- A. Special Installer's Warranty: Installer agrees to repair or replace joint sealants that do not comply with performance and other requirements specified in this Section within specified warranty period.
 - 1. Warranty Period: Two years from date of Substantial Completion.

- B. Special Manufacturer's Warranty: Manufacturer agrees to furnish joint sealants to repair or replace those joint sealants that do not comply with performance and other requirements specified in this Section within specified warranty period.
 - 1. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 JOINT SEALANTS, GENERAL

- A. Compatibility: Provide joint sealants, backings, and other related materials that are compatible with one another and with joint substrates under conditions of service and application, as demonstrated by joint-sealant manufacturer, based on testing and field experience.
- B. Colors of Exposed Joint Sealants: As selected by A/E from manufacturer's full range.

2.2 NONSTAINING SILICONE JOINT SEALANTS

- A. Nonstaining Joint Sealants: No staining of substrates when tested in accordance with ASTM C1248.
- B. Silicone, Nonstaining, S, NS, 100/50, T, NT: Nonstaining, single-component, nonsag, plus 100 percent and minus 50 percent movement capability, traffic- and nontraffic-use, neutral-curing silicone joint sealant; ASTM C920, Type S, Grade NS, Class 100/50, Uses T and NT.
 - 1. Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. The Dow Chemical Company.

2.3 JOINT-SEALANT BACKING

- A. Sealant Backing Material, General: Nonstaining; compatible with joint substrates, sealants, primers, and other joint fillers; and approved for applications indicated by sealant manufacturer based on field experience and laboratory testing.
 - 1. Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Adfast.
 - b. Alcot Plastics Ltd.
 - c. Construction Foam Products; a division of Nomaco, Inc.
 - d. Master Builders Solutions; brand of MBCC Group.
- B. Cylindrical Sealant Backings: ASTM C1330, Type C (closed-cell material with a surface skin), Type O (open-cell material), Type B (bicellular material with a surface skin), or any of the preceding types, as approved in writing by joint-sealant

manufacturer for joint application indicated, and of size and density to control sealant depth and otherwise contribute to producing optimum sealant performance.

2.4 MISCELLANEOUS MATERIALS

- A. Primer: Material recommended by joint-sealant manufacturer where required for adhesion of sealant to joint substrates indicated, as determined from preconstruction joint-sealant-substrate tests and field tests.
- B. Cleaners for Nonporous Surfaces: Chemical cleaners acceptable to manufacturers of sealants and sealant backing materials, free of oily residues or other substances capable of staining or harming joint substrates and adjacent nonporous surfaces in any way, and formulated to promote optimum adhesion of sealants to joint substrates.
- C. Masking Tape: Nonstaining, nonabsorbent material compatible with joint sealants and surfaces adjacent to joints.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Surface Cleaning of Joints: Clean out joints immediately before installing joint sealants to comply with joint-sealant manufacturer's written instructions and the following requirements:
 - 1. Remove all foreign material from joint substrates that could interfere with adhesion of joint sealant, including dust, paints (except for permanent, protective coatings tested and approved for sealant adhesion and compatibility by sealant manufacturer), old joint sealants, oil, grease, waterproofing, water repellents, water, surface dirt, and frost.
 - 2. Clean porous joint substrate surfaces by brushing, grinding, mechanical abrading, or a combination of these methods to produce a clean, sound substrate capable of developing optimum bond with joint sealants. Remove loose particles remaining after cleaning operations above by vacuuming or blowing out joints with oil-free compressed air. Porous joint substrates include the following:
 - a. Concrete.
 - b. Masonry.
 - 3. Remove laitance and form-release agents from concrete.
 - 4. Clean nonporous joint substrate surfaces with chemical cleaners or other means that do not stain, harm substrates, or leave residues capable of interfering with adhesion of joint sealants. Nonporous joint substrates include the following:
 - a. Metal.
- B. Joint Priming: Prime joint substrates where recommended by joint-sealant manufacturer or as indicated by preconstruction joint-sealant-substrate tests or prior experience. Apply primer to comply with joint-sealant manufacturer's written instructions. Confine primers to areas of joint-sealant bond; do not allow spillage or migration onto adjoining surfaces.

- C. Masking Tape: Use masking tape where required to prevent contact of sealant or primer with adjoining surfaces that otherwise would be permanently stained or damaged by such contact or by cleaning methods required to remove sealant smears. Remove tape immediately after tooling without disturbing joint seal.

3.2 INSTALLATION OF JOINT SEALANTS

- A. General: Comply with joint-sealant manufacturer's written installation instructions for products and applications indicated, unless more stringent requirements apply.
- B. Sealant Installation Standard: Comply with recommendations in ASTM C1193 for use of joint sealants as applicable to materials, applications, and conditions indicated.
- C. Install sealant backings of type indicated to support sealants during application and at position required to produce cross-sectional shapes and depths of installed sealants relative to joint widths that allow optimum sealant movement capability.
 - 1. Do not leave gaps between ends of sealant backings.
 - 2. Do not stretch, twist, puncture, or tear sealant backings.
 - 3. Remove absorbent sealant backings that have become wet before sealant application, and replace them with dry materials.
- D. Install bond-breaker tape behind sealants where sealant backings are not used between sealants and backs of joints.
- E. Install sealants using proven techniques that comply with the following and at the same time backings are installed:
 - 1. Place sealants so they directly contact and fully wet joint substrates.
 - 2. Completely fill recesses in each joint configuration.
 - 3. Produce uniform, cross-sectional shapes and depths relative to joint widths that allow optimum sealant movement capability.
- F. Tooling of Nonsag Sealants: Immediately after sealant application and before skinning or curing begins, tool sealants in accordance with requirements specified in subparagraphs below to form smooth, uniform beads of configuration indicated; to eliminate air pockets; and to ensure contact and adhesion of sealant with sides of joint.
 - 1. Remove excess sealant from surfaces adjacent to joints.
 - 2. Use tooling agents that are approved in writing by sealant manufacturer and that do not discolor sealants or adjacent surfaces.
 - 3. Provide concave joint profile in accordance with Figure 8A in ASTM C1193 unless otherwise indicated.
 - 4. Provide flush joint profile at locations indicated on Drawings in accordance with Figure 8B in ASTM C1193.
 - 5. Provide recessed joint configuration of recess depth and at locations indicated on Drawings in accordance with Figure 8C in ASTM C1193.
 - a. Use masking tape to protect surfaces adjacent to recessed tooled joints.

- G. Clean off excess sealant or sealant smears adjacent to joints as the Work progresses by methods and with cleaning materials approved in writing by manufacturers of joint sealants and of products in which joints occur.
- H. Protect joint sealants during and after curing period from contact with contaminating substances and from damage resulting from construction operations or other causes so sealants are without deterioration or damage at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, cut out, remove, and repair damaged or deteriorated joint sealants immediately so installations with repaired areas are indistinguishable from original work.

3.3 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Tests and Inspections:
 - 1. Field-Adhesion Testing: Field test joint-sealant adhesion to joint substrates as follows:
 - a. Extent of Testing: Test completed and cured sealant joints as follows:
 - 1) Perform one test for each 100 ft. of joint length thereafter or one test per each floor per elevation.
 - b. Test Method: Test joint sealants in accordance with Method A, Tail Procedure, in ASTM C1521.
 - 1) For joints with dissimilar substrates, verify adhesion to each substrate separately; extend cut along one side, verifying adhesion to opposite side. Repeat procedure for opposite side.
 - c. Inspect tested joints and report on the following:
 - 1) Whether sealants filled joint cavities and are free of voids.
 - 2) Whether sealant dimensions and configurations comply with specified requirements.
 - 3) Whether sealants in joints connected to pulled-out portion failed to adhere to joint substrates or tore cohesively. Include data on pull distance used to test each kind of product and joint substrate. Compare these results to determine if adhesion complies with sealant manufacturer's field-adhesion hand-pull test criteria.
 - d. Record test results in a field-adhesion-test log. Include dates when sealants were installed, names of persons who installed sealants, test dates, test locations, whether joints were primed, adhesion results and percent elongations, sealant material, sealant configuration, and sealant dimensions.
 - e. Repair sealants pulled from test area by applying new sealants following same procedures used originally to seal joints. Ensure that original sealant surfaces are clean and that new sealant contacts original sealant.
 - 2. Evaluation of Field-Adhesion-Test Results: Sealants not evidencing adhesive failure from testing or noncompliance with other indicated requirements will be considered satisfactory. Remove sealants that fail to adhere to joint substrates during testing or to comply with other requirements. Retest failed applications until test results prove sealants comply with indicated requirements.

C. Prepare test and inspection reports.

END OF SECTION 079200

SECTION 081113 - HOLLOW METAL DOORS AND FRAMES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification Sections, apply to work of this section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Exterior standard steel doors and frames.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: Include the following:
 - 1. Elevations of each door type.
 - 2. Details of doors, including vertical- and horizontal-edge details and metal thicknesses.
 - 3. Frame details for each frame type, including dimensioned profiles and metal thicknesses.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Apex Industries, Inc.
 - 2. BARON Metal Industries, Inc.; ASSA ABLOY of Canada, Ltd.; ASSA ABLOY.
 - 3. Ceco Door; AADG, Inc.; ASSA ABLOY.
 - 4. Daybar Industries, Ltd.
 - 5. Gensteel Doors.
 - 6. National Custom Hollow Metal Doors & Frames.
 - 7. North American Door Corp.
 - 8. Security Metal Products; a brand of ASSA ABLOY.
 - 9. Titan Metal Products.

1.4 PERFORMANCE REQUIREMENTS

- B. Thermally Rated Door Assemblies: Provide door assemblies with U-factor of not more than 0.37 deg Btu/F x h x sq. ft. when tested in accordance with ASTM C1363 or ASTM E1423.

2.2 EXTERIOR STANDARD STEEL DOORS AND FRAMES

- A. Construct hollow-metal doors and frames to comply with standards indicated for materials, fabrication, hardware locations, hardware reinforcement, tolerances, and clearances, and as specified.
- B. Heavy-Duty Doors and Frames: ANSI/SDI A250.8, Level 2; ANSI/SDI A250.4, Level B.
 - 1. Doors:
 - a. Type: As indicated in the Door and Frame Schedule on Drawings.
 - b. Thickness: 1-3/4 inches.
 - c. Face: Metallic-coated steel sheet, minimum thickness of 0.042 inch, with minimum A60 coating.
 - d. Edge Construction: Model 2, Seamless.
 - e. Edge Bevel: Provide manufacturer's standard beveled or square edges.
 - f. Top Edge Closures: Close top edges of doors with flush closures of same material as face sheets. Seal joints against water penetration.
 - g. Bottom Edges: Close bottom edges of doors with end closures or channels of same material as face sheets. Provide weep-hole openings in bottoms of exterior doors to permit moisture to escape.
 - h. Core: Polyisocyanurate.
 - 2. Frames:
 - a. Materials: Metallic-coated steel sheet, minimum thickness of 0.053 inch, with minimum A60 coating.
 - b. Construction: Face welded.

2.3 FRAME ANCHORS

- A. Jamb Anchors:
 - 1. Type: Anchors of minimum size and type required by applicable door and frame standard, and suitable for performance level indicated.
 - 2. Quantity: Minimum of three anchors per jamb, with one additional anchor for frames with no floor anchor. Provide one additional anchor for each 24 inches of frame height above 7 feet.
 - 3. Post-installed Expansion Anchor: Minimum 3/8-inch- diameter bolts with expansion shields or inserts, with manufacturer's standard pipe spacer.
- B. Material: ASTM A879/A879M, Commercial Steel (CS), 04Z coating designation; mill phosphatized.

1. For anchors built into exterior walls, steel sheet complying with ASTM A1008/A1008M or ASTM A1011/A1011M; hot-dip galvanized in accordance with ASTM A153/A153M, Class B.

2.4 MATERIALS

- A. Cold-Rolled Steel Sheet: ASTM A1008/A1008M, Commercial Steel (CS), Type B; suitable for exposed applications.
- B. Hot-Rolled Steel Sheet: ASTM A1011/A1011M, Commercial Steel (CS), Type B; free of scale, pitting, or surface defects; pickled and oiled.
- C. Metallic-Coated Steel Sheet: ASTM A653/A653M, Commercial Steel (CS), Type B.
- D. Inserts, Bolts, and Fasteners: Hot-dip galvanized in accordance with ASTM A153/A153M.
- E. Power-Actuated Fasteners in Concrete: Fastener system of type suitable for application indicated, fabricated from corrosion-resistant materials, with clips or other accessory devices for attaching hollow-metal frames of type indicated.
- F. Mineral-Fiber Insulation: ASTM C665, Type I (blankets without membrane facing); consisting of fibers manufactured from slag or rock wool; with maximum flame-spread and smoke-developed indexes of 25 and 50, respectively; passing ASTM E136 for combustion characteristics.
- G. Glazing: Comply with requirements in Section 088000 "Glazing."

2.5 FABRICATION

- A. Door Astragals: Provide overlapping astragal on one leaf of pairs of doors where required by NFPA 80 for fire-performance rating or where indicated. Extend minimum 3/4 inch beyond edge of door on which astragal is mounted or as required to comply with published listing of qualified testing agency.
- B. Hollow-Metal Frames: Fabricate in one piece except where handling and shipping limitations require multiple sections. Where frames are fabricated in sections, provide alignment plates or angles at each joint, fabricated of metal of same or greater thickness as frames.
 1. Frames: Provide closed tubular members with no visible face seams or joints, fabricated from same material as door frame. Fasten members at crossings and to jambs by welding, or by rigid mechanical anchors.
 2. Provide countersunk, flat- or oval-head exposed screws and bolts for exposed fasteners unless otherwise indicated.
 3. Door Silencers: Except on weather-stripped frames, drill stops to receive door silencers as follows. Keep holes clear during construction.
 - a. Single-Door Frames: Drill stop in strike jamb to receive three door silencers.
 - b. Double-Door Frames: Drill stop in head jamb to receive two door silencers.

- C. Hardware Preparation: Factory prepare hollow-metal doors and frames to receive templated mortised hardware, and electrical wiring; include cutouts, reinforcement, mortising, drilling, and tapping in accordance with ANSI/SDI A250.6, the Door Hardware Schedule on Drawings, and templates.
 - 1. Reinforce doors and frames to receive non-templated, mortised, and surface-mounted door hardware.
 - 2. Comply with BHMA A156.115 for preparing hollow-metal doors and frames for hardware.

- D. Glazed Lites: Provide stops and moldings around glazed lites where indicated. Form corners of stops and moldings with mitered hairline joints.
 - 1. Provide stops and moldings flush with face of door, and with beveled stops unless otherwise indicated.
 - 2. Multiple Glazed Lites: Provide fixed and removable stops and moldings so that each glazed lite is capable of being removed independently.
 - 3. Provide fixed frame moldings on outside of exterior and on secure side of interior doors and frames. Provide loose stops and moldings on inside of hollow-metal doors and frames.
 - 4. Coordinate rabbet width between fixed and removable stops with glazing and installation types indicated.
 - 5. Provide stops for installation with countersunk flat- or oval-head machine screws spaced uniformly not more than 9 inches o.c. and not more than 2 inches o.c. from each corner.

2.6 STEEL FINISHES

- A. Prime Finish: Clean, pretreat, and apply manufacturer's standard primer.
 - 1. Shop Primer: Manufacturer's standard, fast-curing, lead- and chromate-free primer complying with ANSI/SDI A250.10; recommended by primer manufacturer for substrate; compatible with substrate and field-applied coatings despite prolonged exposure.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Remove welded-in shipping spreaders installed at factory. Restore exposed finish by grinding, filling, and dressing, as required to make repaired area smooth, flush, and invisible on exposed faces. Touch up factory-applied finishes where spreaders are removed.

- B. Drill and tap doors and frames to receive non-templated, mortised, and surface-mounted door hardware.

3.2 INSTALLATION

A. Hollow-Metal Frames: Comply with ANSI/SDI A250.11.

1. Set frames accurately in position; plumbed, aligned, and braced securely until permanent anchors are set. After wall construction is complete, remove temporary braces without damage to completed Work.
 - a. Where frames are fabricated in sections, field splice at approved locations by welding face joint continuously; grind, fill, dress, and make splice smooth, flush, and invisible on exposed faces. Touch-up finishes.
 - b. Install frames with removable stops located on secure side of opening.
2. Fire-Rated Openings: Install frames in accordance with NFPA 80.
3. Floor Anchors: Secure with post-installed expansion anchors.
 - a. Floor anchors may be set with power-actuated fasteners instead of post-installed expansion anchors if so indicated and approved on Shop Drawings.
4. Solidly pack mineral-fiber insulation inside frames.
5. Masonry Walls: Coordinate installation of frames to allow for solidly filling space between frames and masonry with grout or mortar.
6. In-Place Concrete or Masonry Construction: Secure frames in place with post-installed expansion anchors. Countersink anchors, and fill and make smooth, flush, and invisible on exposed faces.
7. Installation Tolerances: Adjust hollow-metal frames to the following tolerances:
 - a. Squareness: Plus or minus 1/16 inch, measured at door rabbet on a line 90 degrees from jamb perpendicular to frame head.
 - b. Alignment: Plus or minus 1/16 inch, measured at jambs on a horizontal line parallel to plane of wall.
 - c. Twist: Plus or minus 1/16 inch, measured at opposite face corners of jambs on parallel lines, and perpendicular to plane of wall.
 - d. Plumbness: Plus or minus 1/16 inch, measured at jambs at floor.

B. Hollow-Metal Doors: Fit and adjust hollow-metal doors accurately in frames, within clearances specified below.

1. Non-Fire-Rated Steel Doors: Comply with ANSI/SDI A250.8.
2. Fire-Rated Doors: Install doors with clearances in accordance with NFPA 80.
3. Smoke-Control Doors: Install doors in accordance with NFPA 105.

C. Glazing: Comply with installation requirements in Section 088000 "Glazing" and with hollow-metal manufacturer's written instructions.

3.3 FIELD QUALITY CONTROL

A. Inspection Agency: Engage a qualified inspector to perform inspections and to furnish reports to Architect.

B. Inspections:

1. Fire-Rated Door Inspections: Inspect each fire-rated door in accordance with NFPA 80, Section 5.2.

2. Egress Door Inspections: Inspect each door equipped with panic hardware, each door equipped with fire exit hardware, each door located in an exit enclosure, each electrically controlled egress door, and each door equipped with special locking arrangements in accordance with NFPA 101, Section 7.2.1.15.

- C. Repair or remove and replace installations where inspections indicate that they do not comply with specified requirements.
- D. Reinspect repaired or replaced installations to determine if replaced or repaired door assembly installations comply with specified requirements.
- E. Prepare and submit separate inspection report for each fire-rated door assembly indicating compliance with each item listed in NFPA 80 and NFPA 101.

3.4 REPAIR

- A. Prime-Coat Touchup: Immediately after erection, sand smooth rusted or damaged areas of prime coat and apply touchup of compatible air-drying, rust-inhibitive primer.
- B. Metallic-Coated Surface Touchup: Clean abraded areas and repair with galvanizing repair paint in accordance with manufacturer's written instructions.
- C. Touchup Painting: Cleaning and touchup painting of abraded areas of paint are specified in painting Sections.

END OF SECTION 081113

SECTION 081213 - HOLLOW METAL FRAMES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification Sections, apply to work of this section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Interior standard steel frames.

1.3 DEFINITIONS

- A. Minimum Thickness: Minimum thickness of base metal without coatings according to NAAMM-HMMA 803 or SDI A250.8. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification Sections, apply to work of this section.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: Include the following:
 - 1. Elevations of each frame type.
 - 2. Details of anchorages, joints, field splices, and connections.
 - 3. Details of accessories.
- C. Schedule: Prepared by or under the supervision of supplier, using same reference numbers for details and openings as those on Drawings.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Ceco Door; AADG, Inc.; ASSA ABLOY.
 - 2. JR Metal Frames, Inc.
 - 3. Karpen Steel Custom Doors & Frames.
 - 4. LaForce, LLC.
 - 5. Metropolitan Door Industries Corp.
 - 6. National Custom Hollow Metal Doors & Frames.

7. North American Door Corp.
8. Philipp Manufacturing Co (The).
9. Security Metal Products; a brand of ASSA ABLOY.
10. Titan Metal Products.

2.2 PERFORMANCE REQUIREMENTS

- A. Fire-Rated Assemblies: Assemblies complying with NFPA 80 that are listed and labeled by a qualified testing agency acceptable to authorities having jurisdiction for fire-protection ratings indicated on Drawings, based on testing at positive pressure according to NFPA 252 or UL 10C.
 1. Smoke- and Draft-Control Assemblies: Listed and labeled for smoke and draft control by a qualified testing agency acceptable to authorities having jurisdiction, based on testing according to UL 1784 and installed in compliance with NFPA 105.

2.3 STANDARD STEEL FRAMES

- A. Construct hollow-metal frames to comply with standards indicated for materials, fabrication, hardware locations, hardware reinforcement, tolerances, and clearances, and as specified.
- B. Interior Frames: SDI A250.8. At locations indicated in the Door and Frame Schedule on Drawings.
 1. Materials: Uncoated steel sheet, minimum thickness of 0.042 inch.
 2. Frames: Fabricated from same thickness material as adjacent door frame.
 3. Construction: Knocked down Slip-on drywall Face welded.
 4. Exposed Finish: Prime.

2.4 FRAME ANCHORS

- A. Jamb Anchors:
 1. Type: Anchors of minimum size and type required by applicable door and frame standard, and suitable for performance level indicated.
 2. Quantity: Minimum of three anchors per jamb, with one additional anchor for frames with no floor anchor. Provide one additional anchor for each 24 inches of frame height above 7 feet.
 3. Postinstalled Expansion Anchor: Minimum 3/8-inch diameter bolts with expansion shields or inserts, with manufacturer's standard pipe spacer.
- B. Floor Anchors: Provide floor anchors for each jamb and mullion that extends to floor.
- C. Floor Anchors for Concrete Slabs with Underlayment: Adjustable-type anchors with extension clips, allowing not less than 2-inch height adjustment. Terminate bottom of frames at top of underlayment.
- D. Material: ASTM A879/A879M, Commercial Steel (CS), 04Z coating designation; mill phosphatized.

2.5 MATERIALS

- A. Cold-Rolled Steel Sheet: ASTM A1008/A1008M, Commercial Steel (CS), Type B; suitable for exposed applications.
- B. Hot-Rolled Steel Sheet: ASTM A1011/A1011M, Commercial Steel (CS), Type B; free of scale, pitting, or surface defects; pickled and oiled.
- C. Metallic-Coated Steel Sheet: ASTM A653/A653M, Commercial Steel (CS), Type B.
- D. Inserts, Bolts, and Fasteners: Hot-dip galvanized according to ASTM A153/A153M.
- E. Power-Actuated Fasteners in Concrete: Fabricated from corrosion-resistant materials.

2.6 FABRICATION

- A. Hollow-Metal Frames: Fabricate in one piece except where handling and shipping limitations require multiple sections. Where frames are fabricated in sections, provide alignment plates or angles at each joint, fabricated of metal of same or greater thickness as frames.
 - 1. Frames: Provide closed tubular members with no visible face seams or joints, fabricated from same material as door frame. Fasten members at crossings and to jambs by welding, or by rigid mechanical anchors.
 - 2. Provide countersunk, flat- or oval-head exposed screws and bolts for exposed fasteners unless otherwise indicated.
 - 3. Door Silencers: Except on weather-stripped frames, drill stops to receive door silencers as follows. Keep holes clear during construction.
 - a. Single-Door Frames: Drill stop in strike jamb to receive three door silencers.
 - b. Double-Door Frames: Drill stop in head jamb to receive two door silencers.
- B. Hardware Preparation: Factory prepare hollow-metal frames to receive templated mortised hardware, and electrical wiring; include cutouts, reinforcement, mortising, drilling, and tapping according to SDI A250.6, the Door Hardware Schedule on Drawings, and templates.
 - 1. Reinforce frames to receive nontemplated, mortised, and surface-mounted door hardware.
 - 2. Comply with BHMA A156.115 for preparing hollow-metal frames for hardware.
- C. Glazed Lites: Provide stops and moldings around glazed lites where indicated. Form corners of stops and moldings with mitered hairline joints.
 - 1. Multiple Glazed Lites: Provide fixed and removable stops and moldings so that each glazed lite is capable of being removed independently.
 - 2. Provide fixed frame moldings on outside of exterior and on secure side of interior frames. Provide loose stops and moldings on inside of hollow-metal frames.
 - 3. Coordinate rabbet width between fixed and removable stops with glazing and installation types indicated.
 - 4. Provide stops for installation with countersunk flat- or oval-head machine screws spaced uniformly not more than 9 inches o.c. and not more than 2 inches o.c. from each corner.

2.7 STEEL FINISHES

- A. Prime Finish: Clean, pretreat, and apply manufacturer's standard primer.
 - 1. Shop Primer: SDI A250.10.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. General: Install hollow-metal frames plumb, rigid, properly aligned, and securely fastened in place. Comply with approved Shop Drawings and with manufacturer's written instructions. Comply with SDI A250.11.
- B. Set frames accurately in position; plumbed, aligned, and braced securely until permanent anchors are set. After wall construction is complete, remove temporary braces without damage to completed Work.
 - 1. Where frames are fabricated in sections, field splice at approved locations by welding face joint continuously; grind, fill, dress, and make splice smooth, flush, and invisible on exposed faces. Touch-up finishes.
 - 2. Install frames with removable stops located on secure side of opening.
- C. Fire-Rated Openings: Install frames according to NFPA 80.
- D. Solidly pack mineral-fiber insulation inside frames.
- E. Masonry Walls: Coordinate installation of frames to allow for solidly filling space between frames and masonry with grout or mortar.
- F. In-Place Concrete or Masonry Construction: Secure frames in place with postinstalled expansion anchors. Countersink anchors, and fill and make smooth, flush, and invisible on exposed faces.
- G. Installation Tolerances: Adjust hollow-metal frames to the following tolerances:
 - 1. Squareness: Plus or minus 1/16 inch, measured at door rabbet on a line 90 degrees from jamb perpendicular to frame head.
 - 2. Alignment: Plus or minus 1/16 inch, measured at jambs on a horizontal line parallel to plane of wall.
 - 3. Twist: Plus or minus 1/16 inch, measured at opposite face corners of jambs on parallel lines, and perpendicular to plane of wall.
 - 4. Plumbness: Plus or minus 1/16 inch, measured at jambs at floor.
- H. Glazing: Comply with installation requirements in Section 088000 "Glazing" and with hollow-metal manufacturer's written instructions.

3.2 CLEANING AND TOUCHUP

- A. Prime-Coat Touchup: Immediately after erection, sand smooth rusted or damaged areas of prime coat and apply touchup of compatible air-drying, rust-inhibitive primer.

- B. Metallic-Coated Surface Touchup: Clean abraded areas and repair with galvanizing repair paint according to manufacturer's written instructions.
- C. Factory-Finish Touchup: Clean abraded areas and repair with same material used for factory finish according to manufacturer's written instructions.
- D. Touchup Painting: Cleaning and touchup painting of abraded areas of paint are specified in painting Sections.

END OF SECTION 081213

SECTION 081416 - FLUSH WOOD DOORS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification Sections, apply to work of this section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Five-ply flush wood veneer-faced doors for transparent finish.
 - 2. Factory flush wood doors.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product, including the following:
 - 1. Door core materials and construction.
 - 2. Door edge construction
 - 3. Door face type and characteristics.
 - 4. Door trim for openings.

1.4 CLOSEOUT SUBMITTALS

- A. Quality Standard Compliance Certificates: AWI Quality Certification Program certificates.
- B. Record Documents: For fire-rated doors, list of door numbers and applicable room name and number to which door accesses.

1.5 QUALITY ASSURANCE

- A. Manufacturer's Certification: Licensed participant in AWI's Quality Certification Program.
- B. Fire-Rated Door Inspector Qualifications: Inspector for field quality-control inspections of fire-rated door assemblies complies with qualifications set forth in NFPA 80, Section 5.2.3.1 and the following:
 - 1. DHI's Fire and Egress Door Assembly Inspector (FDAI) certification.
- C. Egress Door Inspector Qualifications: Inspector for field quality-control inspections of egress door assemblies complies with qualifications set forth in NFPA 101, Section 7.2.1.15.4 and the following:
 - 1. DHI's Fire and Egress Door Assembly Inspector (FDAI) certification.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Fire-Rated Wood Door Assemblies: Assemblies complying with NFPA 80 that are listed and labeled by a qualified testing agency acceptable to authorities having jurisdiction, for fire-protection ratings indicated on Drawings, based on testing at positive pressure in accordance with UL 10C or NFPA 252.
 - 1. Oversize Fire-Rated Door Assemblies: For units exceeding sizes of tested assemblies, provide certification by a qualified testing agency that doors comply with standard construction requirements for tested and labeled fire-rated door assemblies except for size.
 - 2. Temperature-Rise Limit: At vertical exit enclosures and exit passageways, provide doors that have a maximum transmitted temperature end point of not more than 450 deg F above ambient after 30 minutes of standard fire-test exposure.

2.2 FLUSH WOOD DOORS AND FRAMES, GENERAL

- A. Quality Standard: In addition to requirements specified, comply with ANSI/WDMA I.S. 1A.
 - 1. Provide labels and certificates from AWI certification program indicating that doors comply with requirements of grades specified.
 - a. Contractor registers the Work under this Section with the AWI Quality Certification Program at www.awiqcp.org or by calling 855-345-0991.
- B. Adhesives: Do not use adhesives that contain urea formaldehyde.
- C. Composite Wood Products: Verify products are made without added urea formaldehyde.

2.3 SOLID-CORE, FIVE-PLY FLUSH WOOD VENEER-FACED DOORS FOR TRANSPARENT FINISH

- A. Interior Doors, Solid-Core Five-Ply Veneer-Faced:
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Lambton Doors.
 - b. Lynden Door, Inc.
 - c. Masonite Architectural.
 - d. Oregon Door.
 - e. Oshkosh Door Company.
 - f. VT Industries, Inc.
 - g. Wilsonart LLC.
 - 2. Performance Grade: ANSI/WDMA I.S. 1A Heavy Duty.
 - 3. Performance Grade by Location:

- a. ANSI/WDMA I.S. 1A Extra Heavy Duty: janitor's closets and exits.
 - b. ANSI/WDMA I.S. 1A Standard Duty: Closets (not including janitor's closets) and private toilets and where indicated on Drawings.
4. ANSI/WDMA I.S. 1A Grade: Premium.
5. Faces: Single-ply wood veneer not less than 1/50 inch thick.
- a. Species: Select white maple.
 - b. Cut: Plain sliced (flat sliced).
 - c. Match between Veneer Leaves: Book match.
 - d. Assembly of Veneer Leaves on Door Faces: Center-balance match.
 - e. Pair and Set Match: Provide for doors hung in same opening.
 - f. Room Match:
 - 1) Match door faces within each separate room or area of building. Corridor-door faces do not need to match where they are separated by 10 feet or more.
 - 2) Provide door faces of compatible color and grain within each separate room or area of building.
 - g. Blueprint Match: Where indicated, provide doors with faces produced from same flitches as adjacent wood paneling and arranged to provide blueprint match with wood paneling.
6. Exposed Vertical and Top Edges: Same species as faces or a compatible species - Architectural Woodwork Standards edge Type A.
- a. Fire-Rated Single Doors: Provide edge construction with intumescent seals concealed by outer stile. Comply with specified requirements for exposed vertical edges.
 - b. Fire-Rated Pairs of Doors:
 - 1) Provide fire-retardant stiles that are listed and labeled for applications indicated without formed-steel edges and astragals. Provide stiles with concealed intumescent seals. Comply with specified requirements for exposed edges.
 - 2) Provide formed-steel edges and astragals with intumescent seals.
 - a) Finish steel edges and astragals with baked enamel.
 - b) Finish steel edges and astragals to match door hardware (locksets or exit devices).
 - c. Mineral-Core Doors: At hinge stiles, provide laminated-edge construction with improved screw-holding capability and split resistance. Comply with specified requirements for exposed edges.
 - 1) Screw-Holding Capability: 550 lbf in accordance with WDMA T.M. 10.
7. Core for Fire-Rated Doors: As required to achieve fire-protection rating indicated on Drawings.
- a. Blocking for Mineral-Core Doors: Provide composite blocking with improved screw-holding capability approved for use in doors of fire-protection ratings indicated on Drawings as needed to eliminate through-bolting hardware.
8. Construction: Five plies, hot-pressed bonded (vertical and horizontal edging is bonded to core), with entire unit abrasive planed before veneering.

2.4 FABRICATION

- A. Factory fit doors to suit frame-opening sizes indicated.
 - 1. Comply with clearance requirements of referenced quality standard for fitting unless otherwise indicated.
 - 2. Comply with NFPA 80 requirements for fire-rated doors.
- B. Factory machine doors for hardware that is not surface applied.
 - 1. Locate hardware to comply with DHI-WDHS-3.
 - 2. Comply with final hardware schedules, door frame Shop Drawings, ANSI/BHMA-156.115-W, and hardware templates.
 - 3. Coordinate with hardware mortises in metal frames, to verify dimensions and alignment before factory machining.
 - 4. For doors scheduled to receive electrified locksets, provide factory-installed raceway and wiring to accommodate specified hardware.
 - 5. Metal Astragals: Factory machine astragals and formed-steel edges for hardware for pairs of fire-rated doors.
- C. Openings: Factory cut and trim openings through doors.
 - 1. Light Openings: Trim openings with moldings of material and profile indicated.
 - 2. Glazing: Factory install glazing in doors indicated to be factory finished. Comply with applicable requirements in Section 088000 "Glazing."
 - 3. Louvers: Factory install louvers in prepared openings.
- D. Exterior Doors: Factory treat exterior doors with water repellent after fabrication has been completed but before factory priming.
 - 1. Flash top of outswinging doors with manufacturer's standard metal flashing.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Hardware: For installation, see Section 087100 "Door Hardware."
- B. Install doors and frames to comply with manufacturer's written instructions and referenced quality standard, and as indicated.
- C. Install frames level, plumb, true, and straight.
 - 1. Shim as required with concealed shims. Install level and plumb to a tolerance of 1/8 inch in 96 inches.
 - 2. Anchor frames to anchors or blocking built in or directly attached to substrates.
 - a. Secure with countersunk, concealed fasteners and blind nailing.
 - b. Use fine finishing nails or finishing screws for exposed fastening, countersunk and filled flush with woodwork.
 - 1) For factory-finished items, use filler matching finish of items being installed.

3. Install fire-rated doors and frames in accordance with NFPA 80.
4. Install smoke- and draft-control doors in accordance with NFPA 105.

D. Job-Fitted Doors:

1. Align and fit doors in frames with uniform clearances and bevels as indicated below.
 - a. Do not trim stiles and rails in excess of limits set by manufacturer or permitted for fire-rated doors.
2. Machine doors for hardware.
3. Seal edges of doors, edges of cutouts, and mortises after fitting and machining.
4. Clearances:
 - a. Provide 1/8 inch at heads, jambs, and between pairs of doors.
 - b. Provide 1/8 inch from bottom of door to top of decorative floor finish or covering unless otherwise indicated on Drawings.
 - c. Where threshold is shown or scheduled, provide 1/4 inch from bottom of door to top of threshold unless otherwise indicated.
 - d. Comply with NFPA 80 for fire-rated doors.
5. Bevel fire-rated doors 1/8 inch in 2 inches at lock edge; trim stiles and rails only to extent permitted by labeling agency.

3.2 ADJUSTING

- A. Operation: Rehang or replace doors that do not swing or operate freely.
- B. Finished Doors: Replace doors that are damaged or that do not comply with requirements. Doors may be repaired or refinished if Work complies with requirements and shows no evidence of repair or refinishing.

END OF SECTION 081416

SECTION 083323 - OVERHEAD COILING DOORS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification Sections, apply to work of this section.

1.2 SUMMARY

- A. Section Includes:

- 1. Insulated service doors.

- B. Related Requirements:

- 1. Section 055000 "Metal Fabrications" for miscellaneous steel supports, door-opening framing, corner guards, and bollards.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type and size of overhead coiling door and accessory.
- B. Shop Drawings: For each installation and for special components not dimensioned or detailed in manufacturer's product data.
 - 1. Include points of attachment and their corresponding static and dynamic loads imposed on structure.
 - 2. Show locations of controls, locking devices detectors or replaceable fusible links, and other accessories.
 - 3. Include diagrams for power, signal, and control wiring.

1.4 QUALITY ASSURANCE

- A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer for both installation and maintenance of units required for this Project.

1.5 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace components of doors that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period: Two years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Accessibility Standard: Comply with applicable provisions in the USDOJ's "2010 ADA Standards for Accessible Design" and ICC A117.1.
- B. Structural Performance, Exterior Doors: Capable of withstanding the following design wind loads:
 - 1. Design Wind Load: As indicated on Drawings.
 - 2. Testing: According to ASTM E330/E330M or DASMA 108 for garage doors and complying with acceptance criteria of DASMA 108.

2.2 DOOR ASSEMBLY

- A. Insulated Service Door: Overhead coiling door formed with curtain of interlocking metal slats.
 - 1. Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. ACME Rolling Doors.
 - b. Cookson; a CornellCookson company.
 - c. Lawrence Roll-Up Doors, Inc.
 - d. Overhead Door Corporation.
 - e. Wayne Dalton; a division of Overhead Door Corporation.
- B. Operation Cycles: Door components and operators capable of operating for not less than 20,000.
- C. Insulated Door Curtain R-Value: 4.5 deg F x h x sq. ft./Btu.
- D. Insulated Door Assembly U-Factor: 0.90 Btu/deg F x h x sq. ft.
- E. Door Curtain Material: Aluminum.
- F. Door Curtain Slats: Flat profile slats with manufacturer's standard center-to-center height dimension for opening width shown on the Drawings.
 - 1. Insulated-Slat Interior Facing: Metal.
- G. Bottom Bar: Two angles, each not less than 1-1/2 by 1-1/2 by 1/8 inch thick; fabricated from stainless steel or aluminum extrusions and finished to match door.
- H. Curtain Jamb Guides: Aluminum with exposed finish matching curtain slats.
- I. Hood: Aluminum.
 - 1. Mounting: Face of wall.
- J. Locking Devices: Equip door with locking device assembly.

1. Locking Device Assembly: Cremone-type, both jamb sides locking bars, operable from inside and outside with cylinders.

K. Electric Door Operator:

1. Usage Classification: Standard duty, up to 25 cycles per hour and up to 90 cycles per day.
2. Safety: Listed according to UL 325 by a qualified testing agency for commercial or industrial use.
3. Motor Exposure: Interior wet, and humid.
4. Motor Electrical Characteristics:
 - a. Provide UL listed electric operator, size as recommended by manufacturer to move door in either direction at not less than 2/3 foot nor more than 1 foot per second.
 - b. Voltage: 115 V ac, single phase, 60 Hz.
5. Emergency Manual Operation: Chain type.
6. Obstruction-Detection Device: Automatic photoelectric sensor electric sensor edge on bottom bar.
7. Control Station(s): Interior mounted.
8. Other Equipment: Audible and visual signals.

L. Curtain Accessories: Equip door with weatherseals and push/pull handles.

M. Door Finish:

1. Aluminum Finish: Anodized color as selected by A/E from full range of industry colors and color densities.
2. Interior Curtain-Slat Facing: Match finish of exterior curtain-slat face.

2.3 MATERIALS, GENERAL

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.4 DOOR CURTAIN MATERIALS AND CONSTRUCTION

- A. Door Curtains: Fabricate overhead coiling-door curtain of interlocking metal slats, designed to withstand wind loading indicated, in a continuous length for width of door without splices. Unless otherwise indicated, provide slats of thickness and mechanical properties recommended by door manufacturer for performance, size, and type of door indicated, and as follows:
1. Vision-Panel Glazing: Manufacturer's standard clear glazing, fabricated from transparent acrylic sheet or fire-protection-rated glass as required for type of door; set in glazing channel secured to curtain slats.
 2. Insulation: Fill slats for insulated doors with manufacturer's standard thermal insulation complying with maximum flame-spread and smoke-developed indexes of 75 and 450, respectively, according to ASTM E84 or UL 723. Enclose insulation completely within slat faces.

3. Metal Interior Curtain-Slat Facing: Match metal of exterior curtain-slat face, with minimum aluminum thickness of 0.032 inch.
 4. Plastic Interior Curtain-Slat Facing: Extruded PVC plastic with maximum flame-spread index of [25] [75] [200] and smoke-developed index of 450, according to ASTM E84 or UL 723.
- B. Curtain Jamb Guides: Manufacturer's standard angles or channels and angles of same material and finish as curtain slats unless otherwise indicated, with sufficient depth and strength to retain curtain, to allow curtain to operate smoothly, and to withstand loading. Slot bolt holes for guide adjustment. Provide removable stops on guides to prevent overtravel of curtain.

2.5 HOODS

- A. General: Form sheet metal hood to entirely enclose coiled curtain and operating mechanism at opening head. Contour to fit end brackets to which hood is attached. Roll and reinforce top and bottom edges for stiffness. Form closed ends for surface-mounted hoods and fascia for any portion of between-jamb mounting that projects beyond wall face. Equip hood with intermediate support brackets as required to prevent sagging.
1. Include automatic drop baffle on fire-rated doors to guard against passage of smoke or flame.
 2. Exterior-Mounted Doors: Fabricate hood to act as weather protection and with a perimeter sealant-joint-bead profile for applying joint sealant.

2.6 LOCKING DEVICES

- A. Slide Bolt: Fabricate with side-locking bolts to engage through slots in tracks for locking by padlock, located on both left and right jamb sides, operable from coil side.
- B. Locking Device Assembly: Fabricate with cylinder lock, spring-loaded dead bolt, operating handle, cam plate, and adjustable locking bars to engage through slots in tracks.
1. Lock Cylinders: As specified in Section 087100 "Door Hardware" and keyed to building keying system.
 2. Keys: Two for each cylinder.
- C. Chain Lock Keeper: Suitable for padlock.
- D. Safety Interlock Switch: Equip power-operated doors with safety interlock switch to disengage power supply when door is locked.

2.7 CURTAIN ACCESSORIES

- A. Smoke Seals: Equip each fire-rated door with replaceable smoke-seal perimeter gaskets or brushes for smoke and draft control as required for door listing and labeling by a qualified testing agency.

- B. Weatherseals for Exterior Doors: Equip each exterior door with weather-stripping gaskets fitted to entire exterior perimeter of door for a weather-resistant installation unless otherwise indicated.
- C. Astragal for Interior Doors: Equip each door bottom bar with a replaceable, adjustable, continuous, compressible gasket of flexible vinyl, rubber, or neoprene as a cushion bumper.
- D. Push/Pull Handles: Equip each push-up-operated or emergency-operated door with lifting handles on each side of door, finished to match door.
- E. Pull-Down Strap: Provide pull-down straps for doors more than 84 inches high.
- F. Pole Hooks: Provide pole hooks and poles for doors more than 84 inches high.

2.8 COUNTERBALANCE MECHANISM

- A. General: Counterbalance doors by means of manufacturer's standard mechanism with an adjustable-tension, steel helical torsion spring mounted around a steel shaft and contained in a spring barrel connected to top of curtain with barrel rings. Use grease-sealed bearings or self-lubricating graphite bearings for rotating members.
- B. Brackets: Manufacturer's standard mounting brackets of either cast iron or cold-rolled steel plate.

2.9 MANUAL DOOR OPERATORS

- A. General: Equip door with manual door operator by door manufacturer.
- B. Push-up Door Operation: Lift handles and pull rope for raising and lowering doors, with counterbalance mechanism designed so that required lift or pull for door operation does not exceed 25 lbf.
- C. Chain-Hoist Operator: Consisting of endless steel hand chain, chain-pocket wheel and guard, and gear-reduction unit with a maximum 25-lbf force for door operation. Provide alloy-steel hand chain with chain holder secured to operator guide.
- D. Crank Operator: Consisting of crank and crank gearbox, steel crank drive shaft, and gear-reduction unit, of type indicated. Size gears to require not more than 25-lbf force to turn crank. Fabricate gearbox to be oiltight and to completely enclose operating mechanism. Provide manufacturer's standard crank-locking device.

2.10 ELECTRIC DOOR OPERATORS

- A. General: Electric door operator assembly of size and capacity recommended and provided by door manufacturer for door and operation-cycles requirement specified, with electric motor and factory-prewired motor controls, starter, gear-reduction unit, solenoid-operated brake, clutch, control stations, control devices, integral gearing for locking door, and accessories required for proper operation.

1. Comply with NFPA 70.
 2. Control equipment complying with NEMA ICS 1, NEMA ICS 2, and NEMA ICS 6, with NFPA 70 Class 2 control circuit, maximum 24-V ac or dc.
- B. Usage Classification: Electric operator and components capable of operating for not less than number of cycles per hour indicated for each door.
- C. Motors: Reversible-type motor with controller (disconnect switch) for motor exposure indicated for each door assembly.
1. Electrical Characteristics: Minimum as indicated for each door assembly. If not indicated, large enough to start, accelerate, and operate door in either direction from any position, at a speed not less than 8 in./sec. and not more than 12 in./sec., without exceeding nameplate ratings or service factor.
 2. Operating Controls, Controllers, Disconnect Switches, Wiring Devices, and Wiring: Manufacturer's standard unless otherwise indicated.
- D. Obstruction-Detection Devices: External entrapment protection consisting of indicated automatic safety sensor capable of protecting full width of door opening. For non-fire-rated doors, activation of device immediately stops and reverses downward door travel.
1. Photoelectric Sensor: Manufacturer's standard system designed to detect an obstruction in door opening without contact between door and obstruction.
 - a. Self-Monitoring Type: Designed to interface with door operator control circuit to detect damage to or disconnection of sensing device. When self-monitoring feature is activated, door closes only with sustained or constant pressure on close button.
 2. Electric Sensor Edge: Automatic safety sensor edge, located within astragal or weather stripping mounted to bottom bar. Contact with sensor activates device. Connect to control circuit using manufacturer's standard take-up reel or self-coiling cable.
 - a. Self-Monitoring Type: Four-wire-configured device designed to interface with door operator control circuit to detect damage to or disconnection of sensor edge.
 3. Pneumatic Sensor Edge: Automatic safety sensor edge, located within astragal or weather stripping mounted to bottom bar. Contact with sensor activates device.
- E. Control Station: Three-button control station in fixed location with momentary-contact push-button controls labeled "Open" and "Stop" and sustained- or constant-pressure push-button control labeled "Close."
1. Interior-Mounted Units: Full-guarded, surface-mounted, heavy-duty type, with general-purpose NEMA ICS 6, Type 1 enclosure.
 2. Exterior-Mounted Units: Full-guarded, standard-duty, surface-mounted, weatherproof type, NEMA ICS 6, Type 4 enclosure, key operated.
- F. Emergency Manual Operation: Equip each electrically powered door with capability for emergency manual operation. Design manual mechanism so required force for door operation does not exceed 25 lbf.

- G. Emergency Operation Disconnect Device: Equip operator with hand-operated disconnect mechanism for automatically engaging manual operator and releasing brake for emergency manual operation while disconnecting motor without affecting timing of limit switch. Mount mechanism so it is accessible from floor level. Include interlock device to automatically prevent motor from operating when emergency operator is engaged.
- H. Motor Removal: Design operator so motor may be removed without disturbing limit-switch adjustment and without affecting emergency manual operation.
- I. Audible and Visual Signals: Audible alarm and visual indicator lights in compliance with the accessibility standard.
- J. Portable Radio-Control System: Consisting of two of the following per door operator:
 - 1. Three-channel universal coaxial receiver to open, close, and stop door.
 - 2. Portable control device to open and stop door may be momentary-contact type; control to close door is to be sustained- or constant-pressure type.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

- A. Install overhead coiling doors and operating equipment complete with necessary hardware, anchors, inserts, hangers, and equipment supports; according to manufacturer's written instructions and as specified.
- B. Fire-Rated Doors: Install according to NFPA 80.
- C. Smoke-Control Doors: Install according to NFPA 80 and NFPA 105.
- D. Power-Operated Doors: Install automatic garage doors openers according to UL 325.

3.2 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections and to furnish reports to A/E.
- B. Perform the following tests and inspections with the assistance of a factory-authorized service representative:
 - 1. Test door release, closing, and alarm operations when activated by smoke detector or building's fire-alarm system. Test manual operation of closed door. Reset door-closing mechanism after successful test.
- C. Repair or remove and replace installations where inspections indicate that they do not comply with specified requirements.
- D. Reinspect repaired or replaced installations to determine if replaced or repaired door assembly installations comply with specified requirements.

3.3 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain overhead coiling doors.

END OF SECTION 083323

SECTION 084313 - ALUMINUM-FRAMED STOREFRONTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification Sections, apply to work of this section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Aluminum-framed storefront systems.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: For aluminum-framed storefronts. Include plans, elevations, sections, full-size details, and attachments to other work.
 - 1. Show connection to and continuity with adjacent thermal, weather, air, and vapor barriers.
- C. Delegated-Design Submittal: For aluminum-framed storefronts indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.4 QUALITY ASSURANCE

- A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer and that employs a qualified glazing contractor for this Project who is certified under the North American Contractor Certification Program (NACC) for Architectural Glass & Metal (AGM) contractors.
- B. Product Options: Information on Drawings and in Specifications establishes requirements for aesthetic effects and performance characteristics of assemblies. Aesthetic effects are indicated by dimensions, arrangements, alignment, and profiles of components and assemblies as they relate to sightlines, to one another, and to adjoining construction.
 - 1. Do not change intended aesthetic effects, as judged solely by A/E, except with A/E's approval. If changes are proposed, submit comprehensive explanatory data to A/E for review.

1.5 WARRANTY

- A. Special Warranty: Installer agrees to repair or replace components of aluminum-framed storefronts that do not comply with requirements or that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period: 10 years from date of Substantial Completion.
- B. Special Finish Warranty, Anodized Finishes: Standard form in which manufacturer agrees to repair finishes or replace aluminum that shows evidence of deterioration of anodized finishes within specified warranty period.
 - 1. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Kawneer Company, Inc.; Arconic Corporation.
 - 2. Trulite Glass & Aluminum Solutions, LLC.
 - 3. Tubelite Inc.
 - 4. U.S. Aluminum; C.R. Laurence Co., Inc.; CRH Americas, Inc.
 - 5. YKK AP America Inc.

2.2 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design aluminum-framed storefronts.
- B. General Performance: Comply with performance requirements specified, as determined by testing of aluminum-framed storefronts representing those indicated for this Project without failure due to defective manufacture, fabrication, installation, or other defects in construction.
 - 1. Aluminum-framed storefronts shall withstand movements of supporting structure, including, but not limited to, twist, column shortening, long-term creep, and deflection from uniformly distributed and concentrated live loads.
 - 2. Failure also includes the following:
 - a. Thermal stresses transferring to building structure.
 - b. Glass breakage.
 - c. Noise or vibration created by wind and thermal and structural movements.
 - d. Loosening or weakening of fasteners, attachments, and other components.
 - e. Failure of operating units.
- C. Structural Loads:
 - 1. Wind Loads: As indicated on Drawings.
 - 2. Other Design Loads: As indicated on Drawings .

- D. Deflection of Framing Members Supporting Glass: At design wind load, as follows:
1. Deflection Normal to Wall Plane: Limited to 1/175 of clear span for spans of up to 13 feet 6 inches and to 1/240 of clear span plus 1/4 inch for spans greater than 13 feet 6 inches.
 2. Deflection Parallel to Glazing Plane: Limited to amount not exceeding that which reduces glazing bite to less than 75 percent of design dimension and that which reduces edge clearance between framing members and glazing or other fixed components to less than 1/8 inch.
 - a. Operable Units: Provide a minimum 1/16-inch clearance between framing members and operable units.
 3. Cantilever Deflection: Limited to 2l/175 at unsupported cantilevers.
- E. Structural: Test in accordance with ASTM E330/E330M as follows:
1. When tested at positive and negative wind-load design pressures, storefront assemblies do not evidence deflection exceeding specified limits.
 2. When tested at 150 percent of positive and negative wind-load design pressures, storefront assemblies, including anchorage, do not evidence material failures, structural distress, or permanent deformation of main framing members exceeding 0.2 percent of span.
 3. Test Durations: As required by design wind velocity, but not less than 10 seconds.
- F. Water Penetration under Static Pressure: Test in accordance with ASTM E331 as follows:
1. No evidence of water penetration through fixed glazing and framing areas when tested in accordance with a minimum static-air-pressure differential of 20 percent of positive wind-load design pressure, but not less than 10 lbf/sq. ft. .
- G. Energy Performance: Certified and labelled by manufacturer for energy performance as follows:
1. Thermal Transmittance (U-factor):
 - a. Fixed Glazing and Framing Areas: U-factor for the system of not more than 0.38 Btu/sq. ft. x h x deg F as determined in accordance with NFRC 100.
 2. Solar Heat Gain Coefficient (SHGC):
 - a. Fixed Glazing and Framing Areas: SHGC for the system of not more than 0.40 as determined in accordance with NFRC 200.
 3. Air Leakage:
 - a. Fixed Glazing and Framing Areas: Air leakage for the system of not more than 0.06 cfm/sq. ft. at a static-air-pressure differential of 6.24 lbf/sq. ft. when tested in accordance with ASTM E283.
 4. Condensation Resistance Factor (CRF):
 - a. Fixed Glazing and Framing Areas: CRF for the system of not less than as determined in accordance with AAMA 1503.
- H. Windborne-Debris Impact Resistance: Passes ASTM E1886 missile-impact and cyclic-pressure tests in accordance with ASTM E1996 for Wind Zone 1 for enhanced protection.

1. Large-Missile Test: For glazing located within 30 feet of grade.
 2. Small-Missile Test: For glazing located between 30 feet and 60 feet above grade.
- I. Thermal Movements: Allow for thermal movements resulting from ambient and surface temperature changes.
1. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.

2.3 ALUMINUM-FRAMED STOREFRONT SYSTEMS

- A. Framing Members: Manufacturer's extruded- or formed-aluminum framing members of thickness required and reinforced as required to support imposed loads.
1. Exterior Framing Construction: Thermally broken.
 2. Glazing System: Retained mechanically with gaskets on four sides.
 3. Glazing Plane: Front.
 4. Finish: Clear anodic finish.
 5. Fabrication Method: Field-fabricated stick system.
 6. Aluminum: Alloy and temper recommended by manufacturer for type of use and finish indicated.
 7. Steel Reinforcement: As required by manufacturer.
- B. Backer Plates: Manufacturer's standard, continuous backer plates for framing members, if not integral, where framing abuts adjacent construction.
- C. Brackets and Reinforcements: Manufacturer's standard high-strength aluminum with nonstaining, nonferrous shims for aligning system components.

2.4 GLAZING

- A. Glazing: Comply with Section 088000 "Glazing."
- B. Glazing Gaskets: Manufacturer's standard sealed-corner pressure-glazing system of black, resilient elastomeric glazing gaskets, setting blocks, and shims or spacers.
- C. Glazing Sealants: As recommended by manufacturer.

2.5 MATERIALS

- A. Sheet and Plate: ASTM B209.
- B. Extruded Bars, Rods, Profiles, and Tubes: ASTM B221.
- C. Structural Profiles: ASTM B308/B308M.
- D. Steel Reinforcement:
1. Structural Shapes, Plates, and Bars: ASTM A36/A36M.
 2. Cold-Rolled Sheet and Strip: ASTM A1008/A1008M.
 3. Hot-Rolled Sheet and Strip: ASTM A1011/A1011M.

- E. Steel Reinforcement Primer: Manufacturer's standard zinc-rich, corrosion-resistant primer complying with SSPC-PS Guide No. 12.00; applied immediately after surface preparation and pretreatment. Select surface preparation methods in accordance with recommendations in SSPC-SP COM, and prepare surfaces in accordance with applicable SSPC standard.

2.6 FABRICATION

- A. Form or extrude aluminum shapes before finishing.
- B. Fabricate components that, when assembled, have the following characteristics:
 - 1. Profiles that are sharp, straight, and free of defects or deformations.
 - 2. Accurately fitted joints with ends coped or mitered.
 - 3. Physical and thermal isolation of glazing from framing members.
 - 4. Accommodations for thermal and mechanical movements of glazing and framing to maintain required glazing edge clearances.
 - 5. Provisions for field replacement of glazing from exterior.
 - 6. Fasteners, anchors, and connection devices that are concealed from view to greatest extent possible.
- C. Mechanically Glazed Framing Members: Fabricate for flush glazing without projecting stops.
- D. After fabrication, clearly mark components to identify their locations in Project in accordance with Shop Drawings.

2.7 ALUMINUM FINISHES

- A. Clear Anodic Finish: AAMA 611, AA-M12C22A31, Class II, 0.010 mm or thicker.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

- A. Comply with manufacturer's written instructions.
- B. Do not install damaged components.
- C. Fit joints to produce hairline joints free of burrs and distortion.
- D. Rigidly secure nonmovement joints.
- E. Install anchors with separators and isolators to prevent metal corrosion and electrolytic deterioration and to prevent impeding movement of moving joints.
- F. Seal perimeter and other joints watertight unless otherwise indicated.
- G. Metal Protection:

1. Where aluminum is in contact with dissimilar metals, protect against galvanic action by painting contact surfaces with materials recommended by manufacturer for this purpose or by installing nonconductive spacers.
 2. Where aluminum is in contact with concrete or masonry, protect against corrosion by painting contact surfaces with bituminous paint.
- H. Set continuous sill members and flashing in full sealant bed, as specified in Section 079200 "Joint Sealants," to produce weathertight installation.
- I. Install joint filler behind sealant as recommended by sealant manufacturer.
- J. Install components plumb and true in alignment with established lines and grades.

3.2 INSTALLATION OF GLAZING

- A. Install glazing as specified in Section 088000 "Glazing."

3.3 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Field Quality-Control Testing: Perform the following test on representative areas of aluminum-framed storefronts.
1. Water-Spray Test: Before installation of interior finishes has begun, areas designated by A/E shall be tested in accordance with AAMA 501.2 and shall not evidence water penetration.
 - a. Perform a minimum of two tests in areas as directed by A/E.
 2. Air Leakage: ASTM E783 at 1.5 times the rate specified for laboratory testing in "Performance Requirements" Article but not more than 0.06 cfm/sq. ft. at a static-air-pressure differential of 1.57 lbf/sq. ft..
 - a. Perform a minimum of two tests in areas as directed by A/E.
 3. Water Penetration: ASTM E1105 at a minimum uniform and cyclic static-air-pressure differential of 0.67 times the static-air-pressure differential specified for laboratory testing in "Performance Requirements" Article, but not less than 6.24 lbf/sq. ft., and shall not evidence water penetration.
- C. Aluminum-framed storefronts will be considered defective if they do not pass tests and inspections.
- D. Prepare test and inspection reports.

END OF SECTION 084313

SECTION 087100 - DOOR HARDWARE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification Sections, apply to work of this section.

1.2 SUMMARY

- A. Section Includes:

1. Hinges.
2. Lock and latch sets.
3. Bolts.
4. Exit devices and auxiliary items.
5. Operating trim.
6. Astragals.
7. Closers.
8. Wall- and floor-mounted stops.
9. Door gasketing.
10. Thresholds.
11. Auxiliary door hardware.

- B. Related Requirements:

1. Section 081113 "Hollow Metal Doors and Frames".
2. Section 083323 "Overhead Coiling Doors" for door hardware provided as part of overhead coiling door assemblies.

1.3 COORDINATION

- A. Installation Templates: Distribute for doors, frames, and other work specified to be factory prepared. Check Shop Drawings of other work to confirm that adequate provisions are made for locating and installing door hardware to comply with indicated requirements.
- B. Security: Coordinate installation of door hardware, keying, and access control with Owner.
- C. Electrical System Roughing-In: Coordinate layout and installation of electrified door hardware with connections to power supplies and building safety and security systems.
- D. Existing Openings: Where hardware components are scheduled for application to existing construction or where modifications to existing door hardware are required, field-verify existing conditions and coordinate installation of door hardware to suit opening conditions and to provide proper door operation.

1.4 ACTION SUBMITTALS

- A. Product Data Submittals: Manufacturers' technical product data for each item of door hardware, installation instructions, maintenance of operating parts and finish, and other information necessary to show compliance with requirements.
- B. Door Hardware Schedule: Prepared by or under the supervision of Installer's Architectural Hardware Consultant. Coordinate door hardware schedule with doors, frames, and related work to ensure proper size, thickness, hand, function, and finish of door hardware.
 - 1. Submittal Sequence: Submit door hardware schedule concurrent with submissions of product data, Samples, and Shop Drawings. Coordinate submission of door hardware schedule with scheduling requirements of other work to facilitate the fabrication of other work that is critical in Project construction schedule.
 - 2. Format: Use same scheduling sequence and format and use same door numbers as in door hardware schedule in the Contract Documents.
 - 3. Content: Include the following information:
 - a. Identification number, location, hand, fire rating, size, and material of each door and frame.
 - b. Locations of each door hardware set, cross-referenced to Drawings on floor plans and to door and frame schedule.
 - c. Complete designations, including name and manufacturer, type, style, function, size, quantity, function, and finish of each door hardware product.
 - d. Fastenings and other installation information.
 - e. Explanation of abbreviations, symbols, and designations contained in door hardware schedule.
 - f. Mounting locations for door hardware.
 - g. List of related door devices specified in other Sections for each door and frame.
- C. Keying Schedule: Prepared by or under the supervision of Installer's Architectural Hardware Consultant, detailing Owner's final keying instructions for locks. Include schematic keying diagram and index each key set to unique door designations that are coordinated with the Contract Documents.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer and Architectural Hardware Consultant.
- B. Sample Warranty: For special warranty.

1.6 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For each type of door hardware to include in maintenance manuals.
- B. Schedules: Final door hardware and keying schedule.

1.7 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish a complete set of specialized tools and maintenance instructions as needed for Owner's continued adjustment, maintenance, and removal and replacement of door hardware.

1.8 QUALITY ASSURANCE

- A. Installer Qualifications: Supplier of products and an employer of workers trained and approved by product manufacturers and of an Architectural Hardware Consultant who is available during the course of the Work to consult Contractor, Architect, and Owner about door hardware and keying.
 - 1. Warehousing Facilities: In Project's vicinity.
 - 2. Scheduling Responsibility: Preparation of door hardware and keying schedule.
- B. Architectural Hardware Consultant Qualifications: A person who is experienced in providing consulting services for door hardware installations that are comparable in material, design, and extent to that indicated for this Project and who is currently certified by DHI as an Architectural Hardware Consultant (AHC).

1.9 DELIVERY, STORAGE, AND HANDLING

- A. Inventory door hardware on receipt and provide secure lockup for door hardware delivered to Project site.
- B. Tag each item or package separately with identification coordinated with the final door hardware schedule, and include installation instructions, templates, and necessary fasteners with each item or package.
- C. Deliver keys to manufacturer of key control system for subsequent delivery to Owner.

1.10 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace components of door hardware that fail in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Structural failures, including excessive deflection, cracking, or breakage.
 - b. Faulty operation of doors and door hardware.
 - c. Deterioration of metals, metal finishes, and other materials beyond normal weathering and use.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

- A. Obtain each type of door hardware from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

- A. Fire-Rated Door Assemblies: Where fire-rated doors are indicated, provide door hardware complying with NFPA 80 that is listed and labeled by a qualified testing agency, for fire-protection ratings indicated, based on testing at positive pressure in accordance with NFPA 252 or UL 10C.
- B. Means of Egress Doors: Latches do not require more than 15 lbf to release the latch. Locks do not require use of a key, tool, or special knowledge for operation.
- C. Accessibility Requirements: For door hardware on doors in an accessible route, comply with ICC A117.1.
 - 1. Provide operating devices that do not require tight grasping, pinching, or twisting of the wrist and that operate with a force of not more than 5 lbf.
 - 2. Comply with the following maximum opening-force requirements:
 - a. Interior, Non-Fire-Rated Hinged Doors: 5 lbf applied perpendicular to door.
 - b. Fire Doors: Minimum opening force allowable by authorities having jurisdiction.
 - 3. Bevel raised thresholds with a slope of not more than 1:2. Provide thresholds not more than 1/2 inch high.
 - 4. Adjust door closer sweep periods so that, from an open position of 90 degrees, the door will take at least 5 seconds to move to a position of 12 degrees from the latch.

2.3 HINGES

- A. Hinges: ANSI/BHMA A156.1. Provide template-produced hinges for hinges installed on hollow-metal doors and hollow-metal frames.
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Bommer Industries, Inc
 - b. Cal-Royal Products, Inc
 - c. Hager Companies.
 - d. Lawrence Hardware Inc.
 - e. McKinney Products Company.
 - f. STANLEY; dormakaba USA, Inc.

2.4 MECHANICAL LOCKS AND LATCHES

- A. Lock Functions: As indicated in door hardware schedule.
- B. Lock Throw: Comply with testing requirements for length of bolts required for labeled fire doors, and as follows:
 - 1. Bored Locks: Minimum 1/2-inch latchbolt throw.
 - 2. Mortise Locks: Minimum 3/4-inch latchbolt throw.
 - 3. Deadbolts: Minimum 1-inch bolt throw.

- C. Lock Backset: 2-3/4 inches unless otherwise indicated.
- D. Strikes: Provide manufacturer's standard strike for each lock bolt or latchbolt complying with requirements indicated for applicable lock or latch and with strike box and curved lip extended to protect frame; finished to match lock or latch.
 - 1. Flat-Lip Strikes: For locks with three-piece antifriction latchbolts, as recommended by manufacturer.
- E. Mortise Locks: ANSI/BHMA A156.13, Operational Grade 2; stamped steel case with steel or brass parts; Series 1000.
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Adams Rite Manufacturing Company.
 - b. Arrow USA.
 - c. BEST Access Solutions, Inc.
 - d. Corbin Russwin, Inc.
 - e. Hager Companies.
 - f. Lawrence Hardware Inc.
 - g. SARGENT Manufacturing Company.
 - h. STANLEY.
 - i. Yale Security Inc.

2.5 LOCK CYLINDERS

- A. Standard Lock Cylinders: ANSI/BHMA A156.5, Grade 1 permanent cores; face finished to match lockset.
 - 1. Core Type: Removable.
- B. Construction Cores: Provide construction cores that are replaceable by permanent cores. Provide 10 construction master keys.

2.6 KEYING

- A. Keying System: Factory registered, complying with guidelines in ANSI/BHMA A156.28, appendix. Provide one extra key blank for each lock.
 - 1. Existing System:
 - a. Master key or grand master key locks to Owner's existing system.
- B. Keys: Nickel silver.
 - 1. Stamping: Permanently inscribe each key with a visual key control number and include the following notation:
 - a. Notation: Information to be furnished by Owner.

2.7 OPERATING TRIM

- A. Operating Trim: ANSI/BHMA A156.6; stainless steel unless otherwise indicated.
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Burns Manufacturing Incorporated.
 - b. Hager Companies.
 - c. Rockwood Manufacturing Company.
 - d. Trimco.

2.8 ACCESSORIES FOR PAIRS OF DOORS

- A. Coordinators: ANSI/BHMA A156.3; consisting of active-leaf, hold-open lever, and inactive-leaf release trigger; fabricated from steel with nylon-coated strike plates; with built-in, adjustable safety release.
- B. Carry-Open Bars: ANSI/BHMA A156.3; prevent the inactive leaf from opening before the active leaf; provide polished brass or bronze carry-open bars with strike plate for inactive leaves of pairs of doors unless automatic or self-latching bolts are used.
- C. Astragals: ANSI/BHMA A156.22.

2.9 SURFACE CLOSERS

- A. Surface Closers: ANSI/BHMA A156.4; rack-and-pinion hydraulic type with adjustable sweep and latch speeds controlled by key-operated valves and forged-steel main arm. Comply with manufacturer's written instructions for size of door closers depending on size of door, exposure to weather, and anticipated frequency of use. Provide factory-sized closers, adjustable to meet field conditions and requirements for opening force.
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Arrow USA.
 - b. Corbin Russwin, Inc.
 - c. dormakaba USA Inc.
 - d. Hager Companies.
 - e. Norton Door Controls.
 - f. Rixson Specialty Door Controls.
 - g. SARGENT Manufacturing Company.
 - h. STANLEY.
 - i. Yale Security Inc.

2.10 MECHANICAL STOPS AND HOLDERS

- A. Wall- and Floor-Mounted Stops: ANSI/BHMA A156.16.
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers

offering products that may be incorporated into the Work include, but are not limited to, the following:

- a. Architectural Builders Hardware Mfg., Inc.
- b. ASI-American Specialties, Inc.
- c. Baldwin.
- d. Burns Manufacturing Incorporated.
- e. Hager Companies.
- f. Rockwood Manufacturing Company.

2.11 DOOR GASKETING

- A. Door Gasketing: ANSI/BHMA A156.22; with resilient or flexible seal strips that are easily replaceable and readily available from stocks maintained by manufacturer.
 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Hager Companies.
 - b. Legacy Manufacturing.
 - c. National Guard Products, Inc.
 - d. Pemko Manufacturing Company Inc.
 - e. Reese Enterprises, Inc.
 - f. Sealeze.
 - g. Zero International.
- B. Maximum Air Leakage: When tested in accordance with ASTM E283/E283M with tested pressure differential of 0.3 inch wg, as follows:
 1. Gasketing on Single Doors: 0.3 cfm/sq. ft. of door opening.
 2. Gasketing on Double Doors: 0.50 cfm per ft. of door opening.

2.12 THRESHOLDS

- A. Thresholds: ANSI/BHMA A156.21; fabricated to full width of opening indicated.
 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Hager Companies.
 - b. Legacy Manufacturing.
 - c. M-D Building Products, Inc.
 - d. National Guard Products, Inc.
 - e. Pemko Manufacturing Company Inc.
 - f. Reese Enterprises, Inc.
 - g. Rixson Specialty Door Controls.
 - h. Sealeze.
 - i. Zero International.

2.13 FABRICATION

- A. Base Metals: Produce door hardware units of base metal indicated, fabricated by forming method indicated, using manufacturer's standard metal alloy, composition, temper, and hardness. Furnish metals of a quality equal to or greater than that of specified door hardware units and ANSI/BHMA A156.18.
- B. Fasteners: Provide door hardware manufactured to comply with published templates prepared for machine, wood, and sheet metal screws. Provide screws that comply with commercially recognized industry standards for application intended; however, aluminum fasteners are not permitted. Provide Phillips flat-head screws with finished heads to match surface of door hardware unless otherwise indicated.
 - 1. Fire-Rated Applications:
 - a. Machine Screws: For the following:
 - 1) Hinges mortised to doors or frames.
 - 2) Strike plates to frames.
 - 3) Closers to doors and frames.
 - b. Steel Through Bolts: For the following unless door blocking is provided:
 - 1) Surface hinges to doors.
 - 2) Closers to doors and frames.
 - 3) Surface-mounted exit devices.
 - 2. Spacers or Sex Bolts: For through bolting of hollow-metal doors.
 - 3. Gasketing Fasteners: Provide noncorrosive fasteners for exterior applications and elsewhere as indicated.

2.14 FINISHES

- A. Provide finishes complying with ANSI/BHMA A156.18 as indicated in door hardware schedule.
- B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- C. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Noticeable variations in the same piece are not acceptable. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine doors and frames, with Installer present, for compliance with requirements for installation tolerances, labeled fire-rated door assembly construction, wall and floor

construction, and other conditions affecting performance of the Work.

- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Steel Doors and Frames: For surface-applied door hardware, drill and tap doors and frames in accordance with ANSI/SDI A250.6.
- B. Wood Doors: Comply with door and hardware manufacturers' written instructions.

3.3 INSTALLATION

- A. Mounting Heights: Mount door hardware units at heights to comply with the following unless otherwise indicated or required to comply with governing regulations.
 - 1. Standard Steel Doors and Frames: ANSI/SDI A250.8.
 - 2. Custom Steel Doors and Frames: HMMA 831.
 - 3. Wood Doors: DHI's "Recommended Locations for Architectural Hardware for Wood Flush Doors."
- B. Install each door hardware item to comply with manufacturer's written instructions. Where cutting and fitting are required to install door hardware onto or into surfaces that are later to be painted or finished in another way, coordinate removal, storage, and reinstallation of surface protective trim units with finishing work. Do not install surface-mounted items until finishes have been completed on substrates involved.
 - 1. Set units level, plumb, and true to line and location. Adjust and reinforce attachment substrates as necessary for proper installation and operation.
 - 2. Drill and countersink units that are not factory prepared for anchorage fasteners. Space fasteners and anchors in accordance with industry standards.
- C. Hinges: Install types and in quantities indicated in door hardware schedule, but not fewer than the number recommended by manufacturer for application indicated or one hinge for every 30 inches of door height, whichever is more stringent, unless other equivalent means of support for door, such as spring hinges or pivots, are provided.
- D. Intermediate Offset Pivots: Where offset pivots are indicated, provide intermediate offset pivots in quantities indicated in door hardware schedule, but not fewer than one intermediate offset pivot per door and one additional intermediate offset pivot for every 30 inches of door height greater than 90 inches.
- E. Lock Cylinders: Install construction cores to secure building and areas during construction period.
 - 1. Furnish permanent cores to Owner for installation.
- F. Key Control System:
 - 1. Key Control Cabinet: Tag keys and place them on markers and hooks in key control system cabinet, as determined by final keying schedule.

2. Key Lock Boxes: Install where indicated or approved by Architect to provide controlled access for fire and medical emergency personnel.
- G. Thresholds: Set thresholds for exterior doors and other doors indicated in full bed of sealant complying with requirements specified in Section 079200 "Joint Sealants."
- H. Stops: Provide floor stops for doors unless wall or other type stops are indicated in door hardware schedule. Do not mount floor stops where they will impede traffic.
- I. Perimeter Gasketing: Apply to head and jamb, forming seal between door and frame.
 1. Do not notch perimeter gasketing to install other surface-applied hardware.
- J. Meeting Stile Gasketing: Fasten to meeting stiles, forming seal when doors are closed.
- K. Door Bottoms: Apply to bottom of door, forming seal with threshold when door is closed.

3.4 FIELD QUALITY CONTROL

- A. Independent Architectural Hardware Consultant: Engage a qualified independent Architectural Hardware Consultant to perform inspections and to prepare inspection reports.
 1. Independent Architectural Hardware Consultant will inspect door hardware and state in each report whether installed work complies with or deviates from requirements, including whether door hardware is properly installed and adjusted.

3.5 ADJUSTING

- A. Initial Adjustment: Adjust and check each operating item of door hardware and each door to ensure proper operation or function of every unit. Replace units that cannot be adjusted to operate as intended. Adjust door control devices to compensate for final operation of heating and ventilating equipment and to comply with referenced accessibility requirements.
 1. Door Closers: Adjust sweep period to comply with accessibility requirements and requirements of authorities having jurisdiction.
 2. Spring Hinges: Adjust to achieve positive latching when door is allowed to close freely from an open position of 70 degrees and so that closing time complies with accessibility requirements of authorities having jurisdiction.
- B. Occupancy Adjustment: Approximately six months after date of Substantial Completion, Installer's Architectural Hardware Consultant is to examine and readjust each item of door hardware, including adjusting operating forces, as necessary to ensure function of doors, door hardware, and electrified door hardware.

3.6 CLEANING AND PROTECTION

- A. Clean adjacent surfaces soiled by door hardware installation.

- B. Clean operating items as necessary to restore proper function and finish.
- C. Provide final protection and maintain conditions that ensure that door hardware is without damage or deterioration at time of Substantial Completion.

3.7 MAINTENANCE SERVICE

- A. Maintenance Tools and Instructions: Furnish a complete set of specialized tools and maintenance instructions for Owner's continued adjustment, maintenance, and removal and replacement of door hardware.

3.8 DOOR HARDWARE SCHEDULE

- A. Hardware Set L1:
 - Hinges
 - Passage set
 - Wall stop
- B. Hardware Set L2:
 - [Not used]
- C. Hardware Set L3:
 - [Not used]
- D. Hardware Set L4:
 - Hinges
 - Push bar/offset pull bar
 - Dead/hook latch with interior thumbturn
 - Astragal
 - Closer
 - Threshold
 - Weatherstripping
 - Floor stop
- E. Hardware Set L5:
 - [Not used]
- F. Hardware Set L6:
 - Hinges
 - Privacy lockset
 - Wall stop
- G. Hardware Set L7:
 - [Not used]
- H. Hardware Set L8:
 - Hinges
 - Office lockset
 - Wall stop

- I. Hardware Set L9:
 - Hinges
 - Entry lockset
 - Deadbolt with interior thumbturn
 - Closer
 - Threshold
 - Weatherstripping
 - Floor stop

END OF SECTION 087100

SECTION 088000 - GLAZING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification Sections, apply to work of this section.

1.2 SUMMARY

- A. Section Includes:
 1. Glass products.
 2. Insulating glass.
 3. Miscellaneous glazing materials.

1.3 COORDINATION

- A. Coordinate glazing channel dimensions to provide necessary bite on glass, minimum edge and face clearances, and adequate sealant thicknesses, with reasonable tolerances to achieve proper safety margins for glazing retention under each design load case, load case combination, and service condition.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Delegated Design Submittal: For glass indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by qualified professional engineer responsible for their preparation.

1.5 INFORMATIONAL SUBMITTALS

- A. Product Certificates: For glass.
- B. Product test reports.
- C. Preconstruction adhesion and compatibility test report.
- D. Sample warranties.

1.6 WARRANTY

- A. Manufacturer's Special Warranty for Coated-Glass Products: Manufacturer agrees to replace coated-glass units that deteriorate within specified warranty period. Deterioration of coated glass is defined as defects developed from normal use that are not attributed to glass breakage or to maintaining and cleaning coated glass contrary to

manufacturer's written instructions. Defects include peeling, cracking, and other indications of deterioration in coating.

1. Warranty Period: 10 years from date of Substantial Completion.

B. Manufacturer's Special Warranty for Insulating Glass: Manufacturer agrees to replace insulating-glass units that deteriorate within specified warranty period. Deterioration of insulating glass is defined as failure of hermetic seal under normal use that is not attributed to glass breakage or to maintaining and cleaning insulating glass contrary to manufacturer's written instructions. Evidence of failure is obstruction of vision by dust, moisture, or film on interior surfaces of glass.

1. Warranty Period: 10 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design glazing.

B. Structural Performance: Glazing shall withstand the following design loads within limits and under conditions indicated determined in accordance with the IBC and ASTM E1300:

1. Design Wind Pressures: As indicated on Drawings.

2. Design Snow Loads: As indicated on Drawings.

3. Thermal Loads: Design glazing to resist thermal stress breakage induced by differential temperature conditions and limited air circulation within individual glass lites and insulated glazing units.

C. Windborne-Debris-Impact Resistance: Exterior glazing shall pass ASTM E1886 missile-impact and cyclic-pressure tests in accordance with ASTM E1996.

1. Large-Missile Test: For glazing located within 30 feet of grade.

2. Small-Missile Test: For glazing located between 30 feet and above grade.

D. Safety Glazing: Where safety glazing is indicated, provide glazing that complies with 16 CFR 1201, Category II.

E. Thermal and Optical Performance Properties: Provide glass with performance properties specified, as indicated in manufacturer's published test data, based on procedures indicated below:

1. U-Factors: Center-of-glazing values, in accordance with NFRC 100 and based on most current non-beta version of LBL's WINDOW computer program, expressed as Btu/sq. ft. x h x deg F.

2. SHGC and Visible Transmittance: Center-of-glazing values, in accordance with NFRC 200 and based on most current non-beta version of LBL's WINDOW computer program.

3. Visible Reflectance: Center-of-glazing values, in accordance with NFRC 300.

2.2 GLASS PRODUCTS, GENERAL

- A. Glazing Publications: Comply with published recommendations of glass product manufacturers and organizations below unless more stringent requirements are indicated. See these publications for glazing terms not otherwise defined in this Section or in referenced standards.
 - 1. NGA Publications: "Glazing Manual."
 - 2. AAMA Publications: AAMA GDSG-1, "Glass Design for Sloped Glazing," and AAMA TIR A7, "Sloped Glazing Guidelines."
 - 3. IGMA Publication for Sloped Glazing: IGMA TB-3001, "Guidelines for Sloped Glazing."
 - 4. IGMA Publication for Insulating Glass: SIGMA TM-3000, "North American Glazing Guidelines for Sealed Insulating Glass Units for Commercial and Residential Use."
- B. Safety Glazing Labeling: Where safety glazing is indicated, permanently mark glazing with certification label of the SGCC or another certification agency acceptable to authorities having jurisdiction or manufacturer. Label shall indicate manufacturer's name, type of glass, thickness, and safety glazing standard with which glass complies.
- C. Insulating-Glass Certification Program: Permanently marked either on spacers or on at least one component lite of units with appropriate certification label of the IGCC.
- D. Thickness: Where glass thickness is indicated, it is a minimum. Provide glass that complies with performance requirements and is not less than thickness indicated.
- E. Strength: Where annealed float glass is indicated, provide annealed float glass, heat-strengthened float glass, or fully tempered float glass as needed to comply with "Performance Requirements" Article. Where heat-strengthened float glass is indicated, provide heat-strengthened float glass or fully tempered float glass as needed to comply with "Performance Requirements" Article. Where fully tempered float glass is indicated, provide fully tempered float glass.

2.3 GLASS PRODUCTS

- A. Fully Tempered Float Glass: ASTM C1048, Kind FT (fully tempered), Condition A (uncoated) unless otherwise indicated, Type I, Class 1 (clear) or Class 2 (tinted) as indicated, Quality-Q3.
- B. Reflective- and Low-E-Coated Vision Glass: ASTM C1376.
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Cardinal Glass Industries, Inc.
 - b. Guardian Glass LLC.
 - c. Pilkington North America; NSG Group.
 - d. Saint-Gobain Glass Corp.
 - e. Vitro Architectural Glass.

2.4 INSULATING GLASS

- A. Insulating-Glass Units: Factory-assembled units consisting of sealed lites of glass separated by a dehydrated interspace, qualified in accordance with ASTM E2190.
 - 1. Sealing System: Dual seal, with manufacturer's standard primary and secondary sealants.
 - 2. Perimeter Spacer: Manufacturer's standard spacer material and construction.
 - a. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1) Saint-Gobain Glass Corp.
 - 2) Technoform Glass Insulation North America.
 - 3) Thermix; a brand of Ensinger USA.
 - 3. Desiccant: Molecular sieve or silica gel, or a blend of both.

2.5 MISCELLANEOUS GLAZING MATERIALS

- A. Cleaners, Primers, and Sealers: Types recommended by sealant or gasket manufacturer.
- B. Setting Blocks:
 - 1. EPDM with Shore A durometer hardness of 85, plus or minus 5.
 - 2. Type recommended in writing by sealant or glass manufacturer.
- C. Spacers:
 - 1. Neoprene blocks or continuous extrusions of hardness required by glass manufacturer to maintain glass lites in place for installation indicated.
 - 2. Type recommended in writing by sealant or glass manufacturer.
- D. Edge Blocks:
 - 1. EPDM with Shore A durometer hardness per manufacturer's written instructions.
 - 2. Type recommended in writing by sealant or glass manufacturer.
- E. Cylindrical Glazing Sealant Backing: ASTM C1330, Type O (open-cell material), of size and density to control glazing sealant depth and otherwise produce optimum glazing sealant performance.

PART 3 - EXECUTION

3.1 GLAZING, GENERAL

- A. Comply with combined written instructions of manufacturers of glass, sealants, gaskets, and other glazing materials, unless more stringent requirements are indicated, including those in referenced glazing publications.
- B. Protect glass edges from damage during handling and installation. Remove damaged glass from Project site and legally dispose of off Project site. Damaged glass includes

glass with edge damage or other imperfections that, when installed, could weaken glass, impair performance, or impair appearance.

- C. Apply primers to joint surfaces where required for adhesion of sealants, as determined by preconstruction testing.
- D. Install setting blocks in sill rabbets, sized and located to comply with referenced glazing publications, unless otherwise required by glass manufacturer. Set blocks in thin course of compatible sealant suitable for heel bead.
- E. Do not exceed edge pressures stipulated by glass manufacturers for installing glass lites.
- F. Provide spacers for glass lites where length plus width is larger than 50 inches.
- G. Provide edge blocking where indicated or needed to prevent glass lites from moving sideways in glazing channel, as recommended in writing by glass manufacturer and in accordance with requirements in referenced glazing publications.

3.2 GASKET GLAZING (DRY)

- A. Cut compression gaskets to lengths recommended by gasket manufacturer to fit openings exactly, with allowance for stretch during installation.
- B. Insert soft compression gasket between glass and frame or fixed stop so it is securely in place with joints miter cut and bonded together at corners.
- C. Installation with Drive-in Wedge Gaskets: Center glass lites in openings on setting blocks and press firmly against soft compression gasket by inserting dense compression gaskets formed and installed to lock in place against faces of removable stops. Start gasket applications at corners and work toward centers of openings. Compress gaskets to produce a weathertight seal without developing bending stresses in glass. Seal gasket joints with sealant recommended in writing by gasket manufacturer.
- D. Installation with Pressure-Glazing Stops: Center glass lites in openings on setting blocks and press firmly against soft compression gasket. Install dense compression gaskets and pressure-glazing stops, applying pressure uniformly to compression gaskets. Compress gaskets to produce a weathertight seal without developing bending stresses in glass. Seal gasket joints with sealant recommended in writing by gasket manufacturer.
- E. Install gaskets so they protrude past face of glazing stops.

3.3 CLEANING AND PROTECTION

- A. Immediately after installation, remove nonpermanent labels and clean surfaces.
- B. Protect glass from contact with contaminating substances resulting from construction operations. Examine glass surfaces adjacent to or below exterior concrete and other masonry surfaces at frequent intervals during construction, but not less than once a month, for buildup of dirt, scum, alkaline deposits, or stains.

1. If, despite such protection, contaminating substances do contact with glass, remove substances immediately as recommended in writing by glass manufacturer. Remove and replace glass that cannot be cleaned without damage to coatings.

C. Remove and replace glass that is damaged during construction period.

3.4 INSULATING GLASS SCHEDULE

A. Low-E-Coated, Tinted Insulating Glass Type:

1. Basis-of-Design Product: Pilkington Solar-E Clear
2. Overall Unit Thickness: 1 inch.
3. Minimum Thickness of Each Glass Lite: 6 mm.
4. U-Value: 0.38.
5. SHGC: 0.40.
6. Shading Coefficient: 0.61.

END OF SECTION 088000

SECTION 088300 - MIRRORS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification Sections, apply to work of this section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Silvered flat glass mirrors.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.

1.4 QUALITY ASSURANCE

- A. Installer Qualifications: A qualified Installer, who employs glass installers for this Project who are certified under the National Glass Association's Certified Glass Installer Program.

1.5 WARRANTY

- A. Special Warranty: Manufacturer agrees to replace mirrors that deteriorate within specified warranty period. Deterioration of mirrors is defined as defects developed from normal use that are not attributed to mirror breakage or to maintaining and cleaning mirrors contrary to manufacturer's written instructions. Defects include discoloration, black spots, and clouding of the silver film.
 - 1. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Avalon Glass and Mirror Company.
 - 2. Gardner Glass, Inc.
 - 3. Glasswerks LA, Inc.
 - 4. National Glass Industries, Inc.
 - 5. Trulite Glass & Aluminum Solutions, LLC.

6. Walker Glass Co., Ltd.

2.2 SILVERED FLAT GLASS MIRRORS

- A. Mirrors, General: ASTM C1503; manufactured using copper-free, low-lead mirror coating process.
- B. Tempered Glass Mirrors: Mirror Glazing Quality for blemish requirements and complying with ASTM C1048 for Kind FT, Condition A, tempered float glass before silver coating is applied.
 - 1. Nominal Thickness: 4.0 mm.
- C. Safety Glazing Products: For film-backed tempered mirrors, provide products that comply with 16 CFR 1201, Category II.

2.3 MISCELLANEOUS MATERIALS

- A. Setting Blocks: Elastomeric material with a Shore, Type A durometer hardness of 85, plus or minus 5.
- B. Edge Sealer: Coating compatible with glass coating and approved by mirror manufacturer for use in protecting against silver deterioration at mirrored glass edges.
- C. Film Backing for Safety Mirrors: Film backing and pressure-sensitive adhesive; both compatible with mirror backing paint as certified by mirror manufacturer.

2.4 MIRROR HARDWARE

- A. Aluminum J-Channels: Aluminum extrusions with a return deep enough to produce a glazing channel to accommodate mirrors of thickness indicated and in lengths required to cover edges of mirrors in a single piece.
 - 1. Aluminum J-Channel Top Trim: J-channels formed with front leg and back leg not less than 5/8 and 1 inch in height, respectively, and a thickness of not less than 0.04 inch.
 - a. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1) Andscot Company, Inc.
 - 2) C.R. Laurence Co., Inc.; CRH Americas, Inc.
 - 3) Stylmark, Inc.
 - 2. Finish: Clear bright anodized.
- B. Fasteners: Fabricated of same basic metal and alloy as fastened metal and matching it in finished color and texture where fasteners are exposed.

2.5 FABRICATION

- A. Fabricate cutouts for notches and holes in mirrors without marring visible surfaces. Locate and size cutouts, so they fit closely around penetrations in mirrors.
- B. Mirror Edge Treatment: Rounded polished.
 - 1. Seal edges of mirrors with edge sealer after edge treatment to prevent chemical or atmospheric penetration of glass coating.
- C. Film-Backed Safety Mirrors: Apply film backing with adhesive coating over mirror backing paint, as recommended in writing by film-backing manufacturer, to produce a surface free of bubbles, blisters, and other imperfections.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, over which mirrors are to be mounted, with Installer present, for compliance with installation tolerances, substrate preparation, and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected and surfaces are dry.

3.2 INSTALLATION

- A. General: Install mirrors to comply with mirror manufacturer's written instructions and with referenced National Glass Association (NGA) publications. Mount mirrors accurately in place in a manner that avoids distorting reflected images.
- B. Install mirrors with mirror hardware. Attach mirror hardware securely to mounting surfaces with mechanical fasteners installed with anchors or inserts as applicable. Install fasteners so heads do not impose point loads on backs of mirrors.
 - 1. Aluminum J-Channels: Provide setting blocks 1/8 inch thick by 4 inches long at quarter points. To prevent trapping water, provide, between setting blocks, two slotted weeps not less than 1/4 inch wide by 3/8 inch long at bottom channel.
- C. Clean exposed surface of mirrors not more than four days before date scheduled for inspections that establish date of Substantial Completion. Clean mirrors as recommended in writing by mirror manufacturer and NGA's publication "Proper Procedures for Cleaning Flat Glass Mirrors."

END OF SECTION 088300

SECTION 092216 - NON-STRUCTURAL METAL FRAMING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification Sections, apply to work of this section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Framing systems.
 - 2. Suspension systems.

1.3 ACTION SUBMITTALS

- A. Product Data: For each product.

1.4 INFORMATIONAL SUBMITTALS

- A. Product Certificates: For each type of code-compliance certification for studs and tracks.
- B. Evaluation reports for high-strength steel studs and tracks post-installed anchors and power-actuated fasteners.

1.5 QUALITY ASSURANCE

- A. Code-Compliance Certification of Studs and Tracks: Provide documentation that framing members are certified according to the product-certification program of the Steel Framing Industry Association the Steel Stud Manufacturers Association or the Supreme Steel Framing System Association.

PART 2 - PRODUCTS

2.1 FRAMING SYSTEMS

- A. Framing Members, General: Comply with AISI S220 and ASTM C645, Section 10 for conditions indicated.
 - 1. Steel Sheet Components: Comply with AISI S220 and ASTM C645, Section 10 requirements for metal unless otherwise indicated.
 - 2. Protective Coating: Comply with AISI S220; ASTM A653/A653M, G40; or coating with equivalent corrosion resistance. Galvannealed products are unacceptable.

- a. Coating demonstrates equivalent corrosion resistance with an evaluation report acceptable to authorities having jurisdiction.
- B. Studs and Track: AISI S220 and ASTM C645, Section 10.
 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. ClarkDietrich.
 - b. Steel Network, Inc. (The).
 2. Minimum Base-Steel Thickness: As required by performance requirements for horizontal deflection 0.0329 inch.
 3. Depth: As indicated on Drawings.
- C. High-Strength Steel Studs and Tracks: Roll-formed with surface deformations to stiffen the framing members.
 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. ClarkDietrich.
 - b. Steel Network, Inc. (The).
 2. Minimum Base-Steel Thickness: As required by horizontal deflection performance requirements 0.0147 inch.
 3. Depth: As indicated on Drawings.
- D. Slip-Type Head Joints: Where indicated, provide the following:
 1. Deflection Track: Steel sheet top track manufactured to prevent cracking of finishes applied to interior partition framing resulting from deflection of structure above; in thickness not less than indicated for studs and in width to accommodate depth of studs.
 - a. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1) ClarkDietrich.
 - 2) Steel Network, Inc. (The).
- E. Flat Strap and Backing Plate: Steel sheet for blocking and bracing in length and width indicated.
 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. ClarkDietrich.
 - b. Steel Network, Inc. (The).
 2. Minimum Base-Steel Thickness: 0.0329 inch.
- F. Cold-Rolled Channel Bridging: Steel, 0.0538-inch minimum base-steel thickness, with minimum 1/2-inch wide flanges.
 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. ClarkDietrich.

- b. Marino\WARE.
 - c. MBA Building Supplies.
 - d. MRI Steel Framing, LLC.
 - e. SCAFCO Steel Stud Company; Stone Group of Companies.
 - f. Steel Construction Systems; Stone Group of Companies.
2. Depth: As indicated on Drawings.
 3. Clip Angle: Not less than 1-1/2 by 1-1/2 inches, 0.068-inch- thick, galvanized steel.

G. Hat-Shaped, Rigid Furring Channels:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. ClarkDietrich.
 - b. Jaimes Industries.
 - c. Marino\WARE.
 - d. MBA Building Supplies.
 - e. MRI Steel Framing, LLC.
 - f. SCAFCO Steel Stud Company; Stone Group of Companies.
 - g. Steel Construction Systems; Stone Group of Companies.
2. Minimum Base-Steel Thickness: As indicated on Drawings.
3. Depth: As indicated on Drawings.

H. Resilient Furring Channels: 1/2-inch deep, steel sheet members designed to reduce sound transmission.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. ClarkDietrich.
 - b. Marino\WARE.
 - c. MBA Building Supplies.
 - d. MRI Steel Framing, LLC.
 - e. SCAFCO Steel Stud Company; Stone Group of Companies.
 - f. Steel Construction Systems; Stone Group of Companies.
2. Configuration: hat shaped.

2.2 SUSPENSION SYSTEMS

- A. Tie Wire: ASTM A641/A641M, Class 1 zinc coating, soft temper, 0.062-inch diameter wire, or double strand of 0.048-inch diameter wire.
- B. Wire Hangers: ASTM A641/A641M, Class 1 zinc coating, soft temper, 0.16 inch in diameter.
- C. Carrying Channels (Main Runners): Cold-rolled, commercial-steel sheet with a base-steel thickness of 0.0538 inch and minimum 1/2-inch-wide flanges.
 1. Depth: As indicated on Drawings.
- D. Furring Channels (Furring Members):
 1. Hat-Shaped, Rigid Furring Channels: 7/8 inch deep.

- a. Minimum Base-Steel Thickness: 0.0179 inch.

2.3 AUXILIARY MATERIALS

- A. General: Provide auxiliary materials that comply with referenced installation standards.
 - 1. Fasteners for Steel Framing: Of type, material, size, corrosion resistance, holding power, and other properties required to fasten steel members to substrates.
- B. Isolation Strip at Exterior Walls: Provide one of the following:
 - 1. Asphalt-Saturated Organic Felt: ASTM D226/D226M, Type I (No. 15 asphalt felt), nonperforated.
 - 2. Foam Gasket: Adhesive-backed, closed-cell vinyl foam strips that allow fastener penetration without foam displacement, 1/8 inch thick, in width to suit steel stud size.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

- A. Installation Standard: ASTM C754.
 - 1. Gypsum Plaster Assemblies: Also comply with requirements in ASTM C841 that apply to framing installation.
 - 2. Portland Cement Plaster Assemblies: Also comply with requirements in ASTM C1063 that apply to framing installation.
 - 3. Gypsum Veneer Plaster Assemblies: Also comply with requirements in ASTM C844 that apply to framing installation.
 - 4. Gypsum Board Assemblies: Also comply with requirements in ASTM C840 that apply to framing installation.
- B. Install framing and accessories plumb, square, and true to line, with connections securely fastened.
- C. Install supplementary framing, and blocking to support fixtures, equipment services, heavy trim, grab bars, toilet accessories, furnishings, or similar construction.
- D. Install bracing at terminations in assemblies.
- E. Do not bridge building control and expansion joints with non-load-bearing steel framing members. Frame both sides of joints independently.

3.2 INSTALLATION OF FRAMING SYSTEMS

- A. Install framing system components according to spacings indicated, but not greater than spacings required by referenced installation standards for assembly types.
- B. Where studs are installed directly against exterior masonry walls or dissimilar metals at exterior walls, install isolation strip between studs and exterior wall.
- C. Install studs so flanges within framing system point in same direction.

- D. Install tracks at floors and overhead supports. Extend framing full height to structural supports or substrates above suspended ceilings except where partitions are indicated to terminate at suspended ceilings. Continue framing around ducts that penetrate partitions above ceiling.
 - 1. Slip-Type Head Joints: Where framing extends to overhead structural supports, install to produce joints at tops of framing systems that prevent axial loading of finished assemblies.
 - 2. Door Openings: Screw vertical studs at jambs to jamb anchor clips on door frames; install track section (for cripple studs) at head and secure to jamb studs.
 - a. Install two studs at each jamb unless otherwise indicated.
 - b. Install cripple studs at head adjacent to each jamb stud, with a minimum 1/2-inch clearance from jamb stud to allow for installation of control joint in finished assembly.
 - c. Extend jamb studs through suspended ceilings and attach to underside of overhead structure.
 - 3. Other Framed Openings: Frame openings other than door openings the same as required for door openings unless otherwise indicated. Install framing below sills of openings to match framing required above door heads.
 - 4. Fire-Resistance-Rated Partitions: Install framing to comply with fire-resistance-rated assembly indicated and support closures and to make partitions continuous from floor to underside of solid structure.
 - a. Firestop Track: Where indicated, install to maintain continuity of fire-resistance-rated assembly indicated.
 - 5. Sound-Rated Partitions: Install framing to comply with sound-rated assembly indicated.
- E. Direct Furring:
 - 1. Screw to wood framing.
 - 2. Attach to concrete or masonry with stub nails, screws designed for masonry attachment, or powder-driven fasteners spaced 24 inches o.c.
- F. Installation Tolerance: Install each framing member so fastening surfaces vary not more than 1/8 inch from the plane formed by faces of adjacent framing.

3.3 INSTALLATION OF SUSPENSION SYSTEMS

- A. Install suspension system components according to spacings indicated, but not greater than spacings required by referenced installation standards for assembly types.
- B. Isolate suspension systems from building structure where they abut or are penetrated by building structure to prevent transfer of loading imposed by structural movement.
- C. Suspend hangers from building structure as follows:
 - 1. Install hangers plumb and free from contact with insulation or other objects within ceiling plenum that are not part of supporting structural or suspension system.
 - a. Splay hangers only where required to miss obstructions and offset resulting horizontal forces by bracing, countersplaying, or other equally effective means.

2. Where width of ducts and other construction within ceiling plenum produces hanger spacings that interfere with locations of hangers required to support standard suspension system members, install supplemental suspension members and hangers in the form of trapezes or equivalent devices.
 - a. Size supplemental suspension members and hangers to support ceiling loads within performance limits established by referenced installation standards.
3. Wire Hangers: Secure by looping and wire tying, either directly to structures or to inserts, eye screws, or other devices and fasteners that are secure and appropriate for substrate, and in a manner that will not cause hangers to deteriorate or otherwise fail.
4. Flat Hangers: Secure to structure, including intermediate framing members, by attaching to inserts, eye screws, or other devices and fasteners that are secure and appropriate for structure and hanger, and in a manner that will not cause hangers to deteriorate or otherwise fail.
5. Do not attach hangers to steel roof deck.
6. Do not attach hangers to permanent metal forms. Furnish cast-in-place hanger inserts that extend through forms.
7. Do not attach hangers to rolled-in hanger tabs of composite steel floor deck.
8. Do not connect or suspend steel framing from ducts, pipes, or conduit.

3.4 FIELD QUALITY CONTROL

- A. Installation Tolerances: Install suspension systems that are level to within 1/8 inch in 12 feet measured lengthwise on each member that will receive finishes and transversely between parallel members that will receive finishes.

END OF SECTION 092216

SECTION 092900 - GYPSUM BOARD

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification Sections, apply to work of this section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Interior gypsum board.
 - 2. Tile backing panels.

1.3 ACTION SUBMITTALS

- A. Product data.

PART 2 - PRODUCTS

2.1 GYPSUM BOARD, GENERAL

- A. Size: Provide maximum lengths and widths available that will minimize joints in each area and that correspond with support system indicated.

2.2 INTERIOR GYPSUM BOARD

- A. Gypsum Wallboard: ASTM C1396/C1396M.
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Armstrong Ceiling & Wall Solutions.
 - b. CertainTeed; SAINT-GOBAIN.
 - c. Georgia-Pacific Gypsum LLC.
 - d. Gold Bond Building Products, LLC provided by National Gypsum Company.
 - e. USG Corporation.
 - 2. Thickness: 1/2 inch.
 - 3. Long Edges: Tapered.
- B. Mold-Resistant Gypsum Board: ASTM C1396/C1396M. With moisture- and mold-resistant core and paper surfaces.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. CertainTeed; SAINT-GOBAIN.
 - b. Georgia-Pacific Gypsum LLC.
 - c. Gold Bond Building Products, LLC provided by National Gypsum Company.
 - d. USG Corporation.
2. Core: Manufacturer's standard.
3. Long Edges: Tapered.
4. Mold Resistance: ASTM D3273, score of 10 as rated in accordance with ASTM D3274.

2.3 TILE & SHOWER BACKING PANELS

- A. Cementitious Backer Units: ANSI A118.9 and ASTM C1288 or ASTM C1325, with manufacturer's standard edges.
 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. FinPan, Inc.
 - b. PermaBASE Building Products, LLC provided by National Gypsum Company.
 - c. USG Corporation.
 2. Thickness: 1/2".
 3. Mold Resistance: ASTM D3273, score of 10 as rated in accordance with ASTM D3274.

2.4 TRIM ACCESSORIES

- A. Interior Trim: ASTM C1047.
 1. Material: Galvanized or aluminum-coated steel sheet, rolled zinc, plastic, or paper-faced galvanized-steel sheet.
 2. Shapes:
 - a. Cornerbead.
 - b. LC-Bead: J-shaped; exposed long flange receives joint compound.
 - c. U-Bead: J-shaped; exposed short flange does not receive joint compound.
 - d. Expansion (control) joint.

2.5 JOINT TREATMENT MATERIALS

- A. General: Comply with ASTM C475/C475M.
- B. Joint Tape:
 1. Interior Gypsum Board: Paper.
 2. Exterior Gypsum Soffit Board: Paper.
 3. Glass-Mat Gypsum Sheathing Board: 10-by-10 glass mesh.

4. Tile Backing Panels: As recommended by panel manufacturer.
- C. Joint Compound for Interior Gypsum Board: For each coat, use formulation that is compatible with other compounds applied on previous or for successive coats.
1. Prefilling: At open joints, rounded or beveled panel edges, and damaged surface areas, use setting-type taping compound.
 2. Embedding and First Coat: For embedding tape and first coat on joints, fasteners, and trim flanges, use drying-type, all-purpose compound.
 - a. Use setting-type compound for installing paper-faced metal trim accessories.
 3. Fill Coat: For second coat, use drying-type, all-purpose compound.
 4. Finish Coat: For third coat, use setting-type, sandable topping compound.
 5. Skim Coat: For final coat of Level 5 finish, use setting-type, sandable topping compound.
- D. Joint Compound for Tile Backing Panels:
1. Glass-Mat, Water-Resistant Backing Panel: As recommended by backing panel manufacturer.
 2. Cementitious Backer Units: As recommended by backer unit manufacturer.

2.6 AUXILIARY MATERIALS

- A. Provide auxiliary materials that comply with referenced installation standards and manufacturer's written instructions.
- B. Steel Drill Screws: ASTM C1002 unless otherwise indicated.
1. Use screws complying with ASTM C954 for fastening panels to steel members from 0.033 to 0.112 inch thick.
 2. For fastening cementitious backer units, use screws of type and size recommended by panel manufacturer.
- C. Sound-Attenuation Blankets: ASTM C665, Type I (blankets without membrane facing) produced by combining thermosetting resins with mineral fibers manufactured from glass, slag wool, or rock wool.
1. Fire-Resistance-Rated Assemblies: Comply with mineral-fiber requirements of assembly.

PART 3 - EXECUTION

3.1 INSTALLATION OF PANELS

- A. Examine panels before installation. Reject panels that are wet, moisture damaged, and mold damaged.
- B. Comply with ASTM C840.

- C. Isolate perimeter of gypsum board applied to non-load-bearing partitions at structural abutments. Provide 1/4- to 1/2-inch- wide spaces at these locations and trim edges with edge trim where edges of panels are exposed. Seal joints between edges and abutting structural surfaces with acoustical sealant.
- D. For trim with back flanges intended for fasteners, attach to framing with same fasteners used for panels. Otherwise, attach trim according to manufacturer's written instructions.

3.2 FINISHING OF GYPSUM BOARD

- A. Prefill open joints and damaged surface areas.
- B. Apply joint tape over gypsum board joints, except for trim products specifically indicated as not intended to receive tape.
- C. Gypsum Board Finish Levels: Finish panels to levels indicated below and in accordance with ASTM C840:
 - 1. Level 1: Ceiling plenum areas, concealed areas, and where indicated.
 - 2. Level 4: At panel surfaces that will be exposed to view unless otherwise indicated.
 - a. Primer and its application to surfaces are specified in Section 099123 "Interior Painting."
- D. Cementitious Backer Units: Finish according to manufacturer's written instructions.

3.3 PROTECTION

- A. Protect installed products from damage from weather, condensation, direct sunlight, construction, and other causes during remainder of the construction period.
- B. Remove and replace panels that are wet, moisture damaged, and mold damaged.

END OF SECTION 092900

SECTION 093013 - CERAMIC TILING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification Sections, apply to work of this section.

1.2 SUMMARY

- A. Section Includes:
 1. Porcelain tile.
 2. Tile backing panels.
 3. Waterproof membranes.
 4. Setting material.
 5. Grout materials.

1.3 ACTION SUBMITTALS

- A. Product Data:
 1. Porcelain tile.
 2. Tile backing panels.
 3. Waterproof membranes.
 4. Setting material.
 5. Grout materials.
- B. Samples:
 1. Full-size units of each type and composition of tile and for each color and finish required.
 2. Full-size units of each type of trim and accessory.

1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer.

1.5 MAINTENANCE MATERIAL SUBMITTALS

- A. Extra Stock Material: Furnish extra materials, from the same production run, to Owner that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 1. Tile and Trim Units: Furnish quantity of full-size units equal to 3 percent of amount installed for each type, composition, color, pattern, and size indicated.

1.6 QUALITY ASSURANCE

A. Installer Qualifications:

1. Installer is a Five-Star member of the National Tile Contractors Association or a Trowel of Excellence member of the Tile Contractors' Association of America.
2. Installer's supervisor for Project holds the International Masonry Institute's Supervisor Certification.
3. Installer employs only Ceramic Tile Education Foundation Certified Installers or installers recognized by the U.S. Department of Labor as Journeyman Tile Layers for Project.

PART 2 - PRODUCTS

2.1 PRODUCTS, GENERAL

- A. ANSI Ceramic Tile Standard: Provide tile that complies with ANSI A137.1 for types, compositions, and other characteristics indicated.
- B. ANSI Standards for Tile Installation Materials: Provide materials complying with ANSI A108.02, ANSI standards referenced in other Part 2 articles, ANSI standards referenced by TCNA installation methods specified in tile installation schedules, and other requirements specified.

2.2 PORCELAIN TILE

A. Porcelain Tile Type: Unglazed.

1. Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. American Olean; a brand of Dal-Tile Corporation.
 - b. Crossville, Inc.
 - c. Daltile; a brand of Dal-Tile Corporation.
 - d. Florida Tile, Inc.
2. Certification: Tile certified by the Porcelain Tile Certification Agency.
3. Face Size: 11-13/16 by 11-13/16 inches.
4. Face Size Variation: Rectified.
5. Thickness: 1/4 inch.
6. Product Use Classification: Interior, Wet (IW).
7. Physical Properties: Chemical resistant when tested with indicated chemicals in accordance with ASTM C650.
8. Tile Color, Glaze, and Pattern: As selected by A/E from manufacturer's full range.
9. Grout Color: As selected by A/E from manufacturer's full range.
10. Precoat with temporary protective coating.
11. Trim Units: Coordinated with sizes and coursing of adjoining flat tile where applicable and matching characteristics of adjoining flat tile. Provide shapes as follows, selected from manufacturer's standard shapes:
 - a. Base Cap: Surface bullnose, module size.

- b. Wainscot Cap: Surface bullnose, module size same as adjoining flat tile.
- c. Wainscot Cap for Flush Conditions: Regular flat tile for conditions where tile wainscot is shown flush with wall surface above it; same size as adjoining flat tile.
- d. External Corners: Surface bullnose, module size same as adjoining flat tile.
- e. Internal Corners: Field-buttet square corners.
- f. Tapered Transition Tile: Shape designed to effect transition between thickness of tile floor and adjoining floor finishes of different thickness, tapered to provide reduction in thickness from 1/2 to 1/4 inch across nominal 4-inch dimension.

2.3 TILE BACKING PANELS

- A. Cementitious Backer Units: ANSI A118.9 and ASTM C1288 or ASTM C1325, with manufacturer's standard edges in maximum lengths available to minimize end-to-end butt joints.
 - 1. Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. CertainTeed; SAINT-GOBAIN.
 - b. Custom Building Products.
 - c. James Hardie Building Products, Inc.
 - d. PermaBASE Building Products, LLC provided by National Gypsum Company.
 - e. USG Corporation.
 - 2. Thickness: 5/8 inch.
 - 3. Mold Resistance: ASTM D3273, score of 10 as rated in accordance with ASTM D3274.

2.4 WATERPROOF MEMBRANES

- A. General: Manufacturer's standard product that complies with ANSI A118.10 and ANSI A118.12 and is recommended by manufacturer for application indicated. Include reinforcement and accessories recommended by manufacturer.
- B. Waterproof Membrane, Fluid Applied: Liquid-latex rubber or elastomeric polymer with continuous fabric reinforcement.
 - 1. Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. ARDEX Americas.
 - b. Bostik; Arkema.
 - c. H.B. Fuller Construction Products Inc. / TEC.
 - d. Laticrete International, Inc.
 - e. MAPEI Corporation.
 - f. Parex USA, Inc.
 - g. Sika Corporation.

2.5 SETTING MATERIALS

A. Modified Dry-Set Mortar (Thinset): ANSI A118.4.

1. Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. ARDEX Americas.
 - b. H.B. Fuller Construction Products Inc. / TEC.
 - c. Laticrete International, Inc.
 - d. MAPEI Corporation.
 - e. Parex USA, Inc.
 - f. Summitville Tiles, Inc.
2. For wall applications, provide mortar that complies with requirements for nonsagging mortar in addition to other requirements in ANSI A118.4.

2.6 GROUT MATERIALS

A. Water-Cleanable Epoxy Grout: ANSI A118.3, with a VOC content of 65 g/L or less.

1. Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. ARDEX Americas.
 - b. Bostik; Arkema.
 - c. H.B. Fuller Construction Products Inc. / TEC.
 - d. Laticrete International, Inc.
 - e. MAPEI Corporation.
 - f. Parex USA, Inc.
 - g. Sika Corporation.
2. Provide product capable of withstanding continuous and intermittent exposure to temperatures of up to 140 and 212 deg F, respectively, and certified by manufacturer for intended use.

2.7 MISCELLANEOUS MATERIALS

A. Trowelable Underlayments and Patching Compounds: Latex-modified, portland cement-based formulation provided or approved by manufacturer of tile-setting and adhesive materials for installations indicated.

B. Metal Transitions:

1. Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Schluter Systems L.P.
 - b. Custom Building Products.
 - c. Progress Profiles America Inc.
2. Description: See Drawings.

3. Material and Finish: Metallic or combination of metal and PVC or neoprene base; polished nickel anodized aluminum exposed-edge material.
- C. Temporary Protective Coating: Formulated to protect exposed surfaces of tile against adherence of mortar and grout; compatible with tile, mortar, and grout products and easily removable after grouting is completed without damaging grout or tile.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions where tile will be installed, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
1. Verify that substrates for setting tile are firm; dry; clean; free of coatings that are incompatible with tile-setting materials, including curing compounds and other substances that contain soap, wax, oil, or silicone; and comply with flatness tolerances required by ANSI A108.01 for installations indicated.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Remove coatings, including curing compounds or other coatings, that are incompatible with tile-setting materials.
- B. Blending: For tile exhibiting color variations, verify that tile has been factory blended and packaged so tile units taken from one package show same range of colors as those taken from other packages and match approved Samples. If not factory blended, either return to manufacturer or blend tiles at Project site before installing.
- C. Substrate Flatness:
1. For tile shorter than 15 inches, confirm that structure or substrate is limited to variation of 1/4 inch in 10 ft. from the required plane, and no more than 1/16 inch in 12 inches when measured from tile surface high points.
 2. For large format tile, tile with at least one edge 15 inches or longer, confirm that structure or substrate is limited to 1/8 inch in 10 ft. from the required plane, and no more than 1/16 inch in 24 inches when measured from tile surface high points.
- D. Field-Applied Temporary Protective Coating: If indicated under tile type or needed to prevent grout from staining or adhering to exposed tile surfaces, precoat them with continuous film of temporary protective coating, taking care not to coat unexposed tile surfaces.

3.3 INSTALLATION OF CERAMIC TILE SYSTEM

- A. Install tile backing panels and treat joints in accordance with ANSI A108.11 and manufacturer's written instructions for type of application indicated.

- B. Install waterproof membrane to comply with ANSI A108.13 and manufacturer's written instructions to produce waterproof membrane of uniform thickness that is bonded securely to substrate.
 - 1. Allow waterproof membrane to cure and verify by testing that it is watertight before installing tile or setting materials over it.
- C. Install crack isolation membrane to comply with ANSI A108.17 and manufacturer's written instructions to produce membrane of uniform thickness that is bonded securely to substrate.
 - 1. Allow crack isolation membrane to cure before installing tile or setting materials over it.
- D. Install tile in accordance with TCNA's "Handbook for Ceramic, Glass, and Stone Tile Installation" for TCNA installation methods specified in tile installation schedules. Comply with parts of ANSI A108 series that are referenced in TCNA installation methods and specified in tile installation schedules, and apply to types of setting and grouting materials used.
- E. Extend tile work into recesses and under or behind equipment and fixtures to form complete covering without interruptions unless otherwise indicated. Terminate work neatly at obstructions, edges, and corners without disrupting pattern or joint alignments.
- F. Accurately form intersections and returns. Perform cutting and drilling of tile without marring visible surfaces. Carefully grind cut edges of tile abutting trim, finish, or built-in items for straight aligned joints. Fit tile closely to electrical outlets, piping, fixtures, and other penetrations so plates, collars, or covers overlap tile.
- G. Provide manufacturer's standard trim shapes where necessary to eliminate exposed tile edges.
- H. Jointing Pattern: Lay tile in grid pattern unless otherwise indicated. Lay out tile work and center tile fields in both directions in each space or on each wall area. Lay out tile work to minimize use of pieces that are less than half of a tile. Provide uniform joint widths unless otherwise indicated.
- I. Lay out tile wainscots to dimensions indicated or to next full tile beyond dimensions indicated.
- J. Movement Joints: Provide movement joints and other sealant-filled joints, including control, contraction, and isolation joints, where indicated on Drawings. Form joints during installation of setting materials, mortar beds, and tile. Keep joints free of dirt, debris, and setting materials prior to filling with sealants. Do not saw-cut joints after installing tiles.
 - 1. Where joints occur in concrete substrates, locate joints in tile surfaces directly above them.

END OF SECTION 093013

SECTION 095123 - ACOUSTICAL TILE CEILINGS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification Sections, apply to work of this section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Acoustical tiles.
 - 2. Metal suspension system.
 - 3. Accessories.
 - 4. Metal edge moldings and trim.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Samples: For each exposed product and for each color and texture specified.

1.4 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Reflected ceiling plans, drawn to scale, and coordinated with each other, using input from installers of the items involved.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Surface-Burning Characteristics: Comply with ASTM E84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
 - 1. Flame-Spread Index: Class A in accordance with ASTM E1264.
 - 2. Smoke-Developed Index: 50 or less.

2.2 ACOUSTICAL TILES

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Armstrong World Industries, Inc.
 - 2. CertainTeed; SAINT-GOBAIN.
 - 3. USG Corporation.

- B. Acoustical Tile Standard: Manufacturer's standard tiles of configuration indicated that comply with ASTM E1264.
- C. Color: As selected from manufacturer's full range.
- D. Edge/Joint Detail: Angled tegular.
- E. Thickness: 5/8 inch.
- F. Modular Size: 24 by 24 inches.

2.3 METAL SUSPENSION SYSTEM

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Armstrong Ceiling & Wall Solutions.
 - 2. USG Corporation.
- B. Metal Suspension-System Standard: Manufacturer's standard, direct-hung, fully concealed, metal suspension system that complies with applicable requirements in ASTM C635/C635M.
- C. Direct-Hung, Double-Web Suspension System: Main and cross runners roll formed from and capped with cold-rolled steel sheet, prepainted, electrolytically zinc coated, or hot-dip galvanized, G30 coating designation.
 - 1. Structural Classification: Intermediate-duty system.
 - 2. Access: Upward and end pivoted or side pivoted, with initial access openings of size indicated below and located throughout ceiling within each module formed by main and cross runners, with additional access available by progressively removing remaining acoustical tiles.
 - a. Initial Access Opening: In each module, 24 by 24 inches.

2.4 ACCESSORIES

- A. Attachment Devices: Size for five times the design load indicated in ASTM C635/C635M, Table 1, "Direct Hung," unless otherwise indicated. Comply with seismic design requirements.

2.5 METAL EDGE MOLDINGS AND TRIM

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Armstrong World Industries, Inc.
 - 2. CertainTeed; SAINT-GOBAIN.
 - 3. Fry Reglet Corporation.
 - 4. USG Corporation.

- B. Roll-Formed, Sheet-Metal Edge Moldings and Trim: Type and profile indicated or, if not indicated, manufacturer's standard moldings for edges and penetrations complying with seismic design requirements; formed from sheet metal of same material, finish, and color as that used for of suspension-system runners.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Measure each ceiling area and establish layout of acoustical tiles to balance border widths at opposite edges of each ceiling. Avoid using less-than-half-width tiles at borders unless otherwise indicated.
- B. Layout openings for penetrations centered on the penetrating items.

3.2 INSTALLATION OF SUSPENDED ACOUSTICAL TILE CEILINGS

- A. Install suspended acoustical tile ceilings in accordance with ASTM C636/C636M and manufacturer's written instructions.
- B. Install edge moldings and trim of type indicated at perimeter of acoustical ceiling area and where necessary to conceal edges of acoustical tiles.
 - 1. Apply acoustical sealant in a continuous ribbon concealed on back of vertical legs of moldings before they are installed.
 - 2. Do not use exposed fasteners, including pop rivets, on moldings and trim.

END OF SECTION 095123

SECTION 096513 - RESILIENT BASE AND ACCESSORIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification Sections, apply to work of this section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Vinyl base.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Samples: For each exposed product and for each color and texture specified.

PART 2 - PRODUCTS

2.1 VINYL BASE

- A. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - 1. Armstrong World Industries, Inc.
- B. Basis of Design: Armstrong 4" coved wall base.
- C. Height: 4 inches.
- D. Lengths: Cut lengths 48 inches long or coils in manufacturer's standard length.
- E. Outside Corners: Job formed or preformed.
- F. Inside Corners: Job formed or preformed.
- G. Colors: Warm Black (see drawings for finish schedule).

2.2 INSTALLATION MATERIALS

- A. Adhesives: Water-resistant type recommended by resilient-product manufacturer for resilient products and substrate conditions indicated.
 - 1. Verify adhesives have a VOC content of 50 g/L or less.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Prepare substrates according to manufacturer's written instructions to ensure adhesion of resilient products.
- B. Concrete Substrates for Resilient Stair Accessories: Prepare horizontal surfaces according to ASTM F 710.
 - 1. Verify that substrates are dry and free of curing compounds, sealers, and hardeners.
 - 2. Remove substrate coatings and other substances that are incompatible with adhesives and that contain soap, wax, oil, or silicone, using mechanical methods recommended by manufacturer. Do not use solvents.
 - 3. Alkalinity and Adhesion Testing: Perform tests recommended by manufacturer. Proceed with installation only after substrate alkalinity falls within range on pH scale recommended by manufacturer in writing, but not less than 5 or more than 9 pH.
 - 4. Moisture Testing: Perform tests so that each test area does not exceed 1000 sq. ft. and perform no fewer than three tests in each installation area and with test areas evenly spaced in installation areas.
 - a. Anhydrous Calcium Chloride Test: ASTM F 1869. Proceed with installation only after substrates have maximum moisture-vapor-emission rate of 3 lb of water/1000 sq. ft. in 24 hours.
 - b. Relative Humidity Test: Using in-situ probes, ASTM F 2170. Proceed with installation only after substrates have a maximum 75 percent relative humidity level measurement.
- C. Fill cracks, holes, and depressions in substrates with trowelable leveling and patching compound; remove bumps and ridges to produce a uniform and smooth substrate.
- D. Do not install resilient products until materials are the same temperature as space where they are to be installed.
- E. Immediately before installation, sweep and vacuum clean substrates to be covered by resilient products.

3.2 RESILIENT BASE INSTALLATION

- A. Comply with manufacturer's written instructions for installing resilient base.
- B. Apply resilient base to walls, columns, pilasters, casework and cabinets in toe spaces, and other permanent fixtures in rooms and areas where base is required.
- C. Install resilient base in lengths as long as practical without gaps at seams and with tops of adjacent pieces aligned.
- D. Tightly adhere resilient base to substrate throughout length of each piece, with base in continuous contact with horizontal and vertical substrates.

- E. Do not stretch resilient base during installation.
- F. On masonry surfaces or other similar irregular substrates, fill voids along top edge of resilient base with manufacturer's recommended adhesive filler material.
- G. Preformed Corners: Install preformed corners before installing straight pieces.
- H. Job-Formed Corners:
 - 1. Outside Corners: Use straight pieces of maximum lengths possible and form with returns not less than 3 inches in length.
 - a. Form without producing discoloration (whitening) at bends.
 - 2. Inside Corners: Use straight pieces of maximum lengths possible and form with returns not less than 3 inches in length.
 - a. Cope corners to minimize open joints.

3.3 RESILIENT ACCESSORY INSTALLATION

- A. Comply with manufacturer's written instructions for installing resilient accessories.
- B. Resilient Molding Accessories: Butt to adjacent materials and tightly adhere to substrates throughout length of each piece. Install reducer strips at edges of floor covering that would otherwise be exposed.

3.4 CLEANING AND PROTECTION

- A. Comply with manufacturer's written instructions for cleaning and protecting resilient products.
- B. Cover resilient products subject to wear and foot traffic until Substantial Completion.

END OF SECTION 096513

SECTION 096516 - RESILIENT SHEET FLOORING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification Sections, apply to work of this section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Vinyl sheet flooring with backing.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Samples: For each exposed product and for each color, texture, and pattern specified.

1.4 CLOSEOUT SUBMITTALS

- A. Maintenance data.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: An entity that employs installers and supervisors who are competent in techniques required by manufacturer for resilient sheet flooring installation and seaming method indicated.
 - 1. Engage an installer who employs workers for this Project who are trained or certified by resilient sheet flooring manufacturer for installation techniques required.

PART 2 - PRODUCTS

2.1 VINYL SHEET FLOORING

- A. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - 1. Armstrong Flooring, Inc.
- B. Basis of Design: Natralis; SafetyZone.
- C. Sheet Width: As standard with manufacturer.
- D. Colors: Sand Dune; Blueberry Swirl (see drawings for room finish schedule).

2.2 INSTALLATION MATERIALS

- A. Adhesives: Water-resistant type recommended by flooring and adhesive manufacturers to suit resilient sheet flooring and substrate conditions indicated.
- B. Seamless-Installation Accessories:
 - 1. Heat-Welding Bead: Manufacturer's solid-strand product for heat welding seams.
 - a. Colors: Match flooring.
 - 2. Chemical-Bonding Compound: Manufacturer's product for chemically bonding seams.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Prepare substrates according to resilient sheet flooring manufacturer's written instructions to ensure adhesion of resilient sheet flooring.
- B. Concrete Substrates: Prepare according to ASTM F 710.
 - 1. Verify that substrates are dry and free of curing compounds, sealers, and hardeners.
 - 2. Remove substrate coatings and other substances that are incompatible with adhesives and that contain soap, wax, oil, or silicone, using mechanical methods recommended by resilient sheet flooring manufacturer. Do not use solvents.
 - 3. Alkalinity and Adhesion Testing: Perform tests recommended by resilient sheet flooring manufacturer. Proceed with installation only after substrate alkalinity falls within range on pH scale recommended by manufacturer in writing, but not less than 5 or more than 9 pH.
 - 4. Moisture Testing: Perform tests so that each test area does not exceed 1000 sq. ft. and perform no fewer than three tests in each installation area and with test areas evenly spaced in installation areas.
 - a. Anhydrous Calcium Chloride Test: ASTM F 1869. Proceed with installation only after substrates have maximum moisture-vapor-emission rate of 3 lb of water/1000 sq. ft. in 24 hours.
 - b. Relative Humidity Test: Using in-situ probes, ASTM F 2170. Proceed with installation only after substrates have a maximum 75 percent relative humidity level measurement.
- C. Fill cracks, holes, and depressions in substrates with trowelable leveling and patching compound; remove bumps and ridges to produce a uniform and smooth substrate.
- D. Do not install resilient sheet flooring until materials are the same temperature as space where they are to be installed.
 - 1. At least 48 hours in advance of installation, move flooring and installation materials into spaces where they will be installed.
- E. Immediately before installation, sweep and vacuum clean substrates to be covered by resilient sheet flooring.

3.2 RESILIENT SHEET FLOORING INSTALLATION

- A. Comply with manufacturer's written instructions for installing resilient sheet flooring.
- B. Unroll resilient sheet flooring and allow it to stabilize before cutting and fitting.
- C. Lay out resilient sheet flooring as follows:
 - 1. Maintain uniformity of flooring direction.
 - 2. Minimize number of seams; place seams in inconspicuous and low-traffic areas, at least 6 inches away from parallel joints in flooring substrates.
 - 3. Match edges of flooring for color shading at seams.
 - 4. Avoid cross seams.
- D. Scribe and cut resilient sheet flooring to butt neatly and tightly to vertical surfaces and permanent fixtures including built-in furniture, cabinets, pipes, outlets, and door frames.
- E. Extend resilient sheet flooring into toe spaces, door reveals, closets, and similar openings.
- F. Maintain reference markers, holes, and openings that are in place or marked for future cutting by repeating on resilient sheet flooring as marked on substrates. Use chalk or other nonpermanent marking device.
- G. Install resilient sheet flooring on covers for telephone and electrical ducts and similar items in installation areas. Maintain overall continuity of color and pattern between pieces of flooring installed on covers and adjoining flooring. Tightly adhere flooring edges to substrates that abut covers and to cover perimeters.
- H. Adhere resilient sheet flooring to substrates using a full spread of adhesive applied to substrate to produce a completed installation without open cracks, voids, raising and puckering at joints, telegraphing of adhesive spreader marks, and other surface imperfections.
- I. Seamless Installation:
 - 1. Heat-Welded Seams: Comply with ASTM F 1516. Rout joints and heat weld with welding bead to fuse sections permanently into a seamless flooring installation. Prepare, weld, and finish seams to produce surfaces flush with adjoining flooring surfaces.
 - 2. Chemically Bonded Seams: Bond seams with chemical-bonding compound to fuse sections permanently into a seamless flooring installation. Prepare seams and apply compound to produce tightly fitted seams without gaps, overlays, or excess bonding compound on flooring surfaces.
- J. Integral-Flash-Cove Base: Cove resilient sheet flooring 4 inches up vertical surfaces. Support flooring at horizontal and vertical junction with cove strip. Butt at top against cap strip.
 - 1. Install metal corners at inside and outside corners.

END OF SECTION 096516

SECTION 096519 - RESILIENT TILE FLOORING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification Sections, apply to work of this section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Vinyl composition floor tile.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Samples: For each exposed product and for each color and pattern specified.

1.4 CLOSEOUT SUBMITTALS

- A. Maintenance data.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: An entity that employs installers and supervisors who are competent in techniques required by manufacturer for floor tile installation.

PART 2 - PRODUCTS

2.1 VINYL COMPOSITION FLOOR TILE

- A. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - 1. Armstrong Flooring, Inc.
- B. Basis of Design: Parallel USA.
- C. Size: 18x18.
- D. Colors: Havana Toast.

2.2 INSTALLATION MATERIALS

- A. Adhesives: Water-resistant type recommended by floor tile and adhesive manufacturers to suit floor tile and substrate conditions indicated.
 - 1. Verify adhesives have a VOC content of 50 g/L or less.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Prepare substrates according to floor tile manufacturer's written instructions to ensure adhesion of resilient products.
- B. Concrete Substrates: Prepare according to ASTM F 710.
 - 1. Verify that substrates are dry and free of curing compounds, sealers, and hardeners.
 - 2. Remove substrate coatings and other substances that are incompatible with adhesives and that contain soap, wax, oil, or silicone, using mechanical methods recommended by floor tile manufacturer. Do not use solvents.
 - 3. Alkalinity and Adhesion Testing: Perform tests recommended by floor tile manufacturer. Proceed with installation only after substrate alkalinity falls within range on pH scale recommended by manufacturer in writing, but not less than 5 or more than 9 pH.
 - 4. Moisture Testing: Perform tests so that each test area does not exceed 1000 sq. ft. , and perform no fewer than three tests in each installation area and with test areas evenly spaced in installation areas.
 - a. Anhydrous Calcium Chloride Test: ASTM F 1869. Proceed with installation only after substrates have maximum moisture-vapor-emission rate of 3 lb of water/1000 sq. ft. in 24 hours.
 - b. Relative Humidity Test: Using in-situ probes, ASTM F 2170. Proceed with installation only after substrates have a maximum 75 percent relative humidity level measurement.
- C. Fill cracks, holes, and depressions in substrates with trowelable leveling and patching compound; remove bumps and ridges to produce a uniform and smooth substrate.
- D. Do not install floor tiles until materials are the same temperature as space where they are to be installed.
 - 1. At least 48 hours in advance of installation, move resilient floor tile and installation materials into spaces where they will be installed.
- E. Immediately before installation, sweep and vacuum clean substrates to be covered by resilient floor tile.

3.2 FLOOR TILE INSTALLATION

- A. Comply with manufacturer's written instructions for installing floor tile.

- B. Lay out floor tiles from center marks established with principal walls, discounting minor offsets, so tiles at opposite edges of room are of equal width. Adjust as necessary to avoid using cut widths that equal less than one-half tile at perimeter.
 - 1. Lay tiles square with room axis.
- C. Match floor tiles for color and pattern by selecting tiles from cartons in the same sequence as manufactured and packaged, if so numbered. Discard broken, cracked, chipped, or deformed tiles.
 - 1. Lay tiles with grain direction alternating in adjacent tiles (basket-weave pattern) .
- D. Scribe, cut, and fit floor tiles to butt neatly and tightly to vertical surfaces and permanent fixtures including built-in furniture, cabinets, pipes, outlets, and door frames.
- E. Extend floor tiles into toe spaces, door reveals, closets, and similar openings. Extend floor tiles to center of door openings.
- F. Maintain reference markers, holes, and openings that are in place or marked for future cutting by repeating on floor tiles as marked on substrates. Use chalk or other nonpermanent marking device.
- G. Install floor tiles on covers for telephone and electrical ducts, building expansion-joint covers, and similar items in installation areas. Maintain overall continuity of color and pattern between pieces of tile installed on covers and adjoining tiles. Tightly adhere tile edges to substrates that abut covers and to cover perimeters.
- H. Adhere floor tiles to substrates using a full spread of adhesive applied to substrate to produce a completed installation without open cracks, voids, raising and puckering at joints, telegraphing of adhesive spreader marks, and other surface imperfections.

END OF SECTION 096519

SECTION 099100 - PAINTING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes surface preparation and field painting of exposed exterior and interior items and surfaces.
 - 1. Surface preparation, priming, and finish coats specified in this Section are in addition to shop priming and surface treatment specified in other Sections.
- B. Do not paint prefinished items, concealed surfaces, finished metal surfaces, operating parts, and labels.
 - 1. Prefinished items include the following factory-finished components: Review list of prefinished items below. Delete items not in Project; insert additional items to suit Project.
 - a. Acoustical wall panels.
 - b. Metal toilet enclosures.
 - c. Metal lockers.
 - d. Finished mechanical and electrical equipment.

1.3 DEFINITIONS

- A. General: Standard coating terms defined in ASTM D 16 apply to this Section.
 - 1. Flat refers to a lusterless or matte finish with a gloss range below 15 when measured at an 85-degree meter.
 - 2. Low Luster (Eggshell) refers to low-sheen finish with a gloss range between 20 and 35 when measured at a 60-degree meter.
 - 3. Semigloss refers to medium-sheen finish with a gloss range between 35 and 70 when measured at a 60-degree meter.
 - 4. Full gloss refers to high-sheen finish with a gloss range more than 70 when measured at a 60-degree meter.

1.4 SUBMITTALS

- A. Product Data: For each paint system indicated. Include block fillers and primers.
 - 1. Material List: An inclusive list of required coating materials. Indicate each material and cross-reference specific coating, finish system, and application. Identify each material by manufacturer's catalog number and general classification.

2. Manufacturer's Information: Manufacturer's technical information, including label analysis and instructions for handling, storing, and applying each coating material.
- B. Samples for Initial Selection: For each type of finish-coat material indicated.
 1. After color selection, Architect will furnish color chips for surfaces to be coated.
 - C. Samples for Verification: For each color and material to be applied, with texture to simulate actual conditions, on representative Samples of the actual substrate.
 1. Provide 12-inch square Samples, defining each separate coat, including block fillers and primers. Use representative colors when preparing Samples for review. Resubmit until required sheen, color, and texture are achieved.

1.5 QUALITY ASSURANCE

- A. Applicator Qualifications: A firm or individual experienced in applying paints and coatings similar in material, design, and extent to those indicated for this Project, whose work has resulted in applications with a record of successful in-service performance.
- B. Source Limitations: Obtain block fillers and primers for each coating system from the same manufacturer as the finish coats.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver materials to Project site in manufacturer's original, unopened packages and containers bearing manufacturer's name and label and the following information:
 1. Product name or title of material.
 2. Product description (generic classification or binder type).
 3. Manufacturer's stock number and date of manufacture.
 4. Contents by volume, for pigment and vehicle constituents.
 5. Thinning instructions.
 6. Application instructions.
 7. Color name and number.
- B. Store materials not in use in tightly covered containers in a well-ventilated area at a minimum ambient temperature of 45 deg F. Maintain storage containers in a clean condition, free of foreign materials and residue.
 1. Protect from freezing. Keep storage area neat and orderly. Remove oily rags and waste daily.

1.7 PROJECT CONDITIONS

- A. Apply waterborne paints only when temperatures of surfaces to be painted and surrounding air are between 50 and 90 deg F.
- B. Do not apply paint in snow, rain, fog, or mist; or when relative humidity exceeds 85 percent; or at temperatures less than 5 deg F above the dew point; or to damp or wet surfaces.

1.8 EXTRA MATERIALS

- A. Provide extra paint applied to surfaces. Deliver extra materials to Owner.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Products: Subject to compliance with requirements, provide one of the products listed.
- B. Manufacturers' Names: Shortened versions (shown in parentheses) of the following manufacturers' names are used in other Part 2 articles:
 - 1. Benjamin Moore & Co. (Benjamin Moore).
 - 2. PPG Industries, Inc. (Pittsburgh Paints).
 - 3. Sherwin-Williams Co. (Sherwin-Williams).
 - 4. Tnemec.

2.2 PAINT MATERIALS, GENERAL

- A. Material Compatibility: Provide block fillers, primers, and finish-coat materials that are compatible with one another and with the substrates indicated under conditions of service and application, as demonstrated by manufacturer based on testing and field experience.
- B. Material Quality: Provide manufacturer's best-quality paint material of the various coating types specified that are factory formulated and recommended by manufacturer for application indicated. Paint-material containers not displaying manufacturer's product identification will not be acceptable.
 - 1. Proprietary Names: Use of manufacturer's proprietary product names to designate colors or materials is not intended to imply that products named are required to be used to the exclusion of equivalent products of other manufacturers. Furnish manufacturer's material data and certificates of performance for proposed substitutions.

2.3 CONCRETE UNIT MASONRY BLOCK FILLERS

- A. Concrete Unit Masonry Block Filler: Factory-formulated high-performance latex block fillers.
 - 1. Benjamin Moore; Moorcraft Super Craft Latex Block Filler No. 285: Applied at a dry film thickness of not less than 8.1 mils.
 - 2. Benjamin Moore; Moore's IMC Latex Block Filler No. M88: Applied at a dry film thickness of not less than 8.1 mils.
 - 3. Pittsburgh Paints; 6-7 SpeedHide Interior/Exterior Masonry Latex Block Filler: Applied at a dry film thickness of not less than 6.0 to 12.5 mils.
 - 4. Sherwin-Williams; PrepRite Interior/Exterior Block Filler B25W25: Applied at a dry film thickness of not less than 8.0 mils.

2.4 EXTERIOR PRIMERS

- A. Exterior Concrete and Masonry Primer: Factory-formulated alkali-resistant acrylic-latex primer for exterior application.
 - 1. Benjamin Moore; Moore's Acrylic Masonry Sealer No. 066: Applied at a dry film thickness of not less than 0.7 mils.
 - 2. Benjamin Moore; Moore's Alkyd Masonry Sealer No. 077: Applied at a dry film thickness of not less than 2.7 mils.
 - 3. Pittsburgh Paints; 6-603 SpeedHide Interior/Exterior Acrylic Latex Alkali Resistant Primer: Applied at a dry film thickness of not less than 1.5 mils.
 - 4. Sherwin-Williams; Loxon Exterior Masonry Acrylic Primer A24W300: Applied at a dry film thickness of not less than 3.0 mils.
 - 5. Sherwin-Williams; A-100 Latex Exterior Wood Primer B42W41: Applied at a dry film thickness of not less than 1.4 mils.

- B. Exterior Wood Primer for Acrylic Enamels: Factory-formulated alkyd or latex wood primer for exterior application.
 - 1. Benjamin Moore; Moorcraft Super Spec Alkyd Exterior Primer No. 176: Applied at a dry film thickness of not less than 1.8 mils.
 - 2. Pittsburgh Paints; 6-609 SpeedHide Exterior House & Trim Wood Primer 100 Percent Acrylic Latex: Applied at a dry film thickness of not less than 1.6 mils.
 - 3. Sherwin-Williams; A-100 Exterior Latex Wood Primer B42W41: Applied at a dry film thickness of not less than 1.4 mils.

- C. Exterior Galvanized Metal Primer: Factory-formulated galvanized metal primer for exterior application.
 - 1. Benjamin Moore; Moore's IMC Acrylic Metal Primer No. M04: Applied at a dry film thickness of not less than 2.0 mils.
 - 2. Pittsburgh Paints; 90-709 Pitt-Tech One Pack Interior/Exterior Primer/Finish DTM Industrial Enamel: Applied at a dry film thickness of not less than 3.0 mils.
 - 3. Sherwin-Williams; primer not required over this substrate.
 - 4. Sherwin-Williams; Galvite HS Paint B50WZ3: Applied at a dry film thickness of not less than 2.0 mils.

2.5 INTERIOR PRIMERS

- A. Interior Concrete and Masonry Primer: Factory-formulated alkali-resistant acrylic-latex interior primer for interior application.
 - 1. Benjamin Moore; Moorcraft Super Spec Latex Enamel Undercoater & Primer Sealer No. 253: Applied at a dry film thickness of not less than 1.2 mils.
 - 2. Pittsburgh Paints; 6-2 SpeedHide Interior Quick-Drying Latex Sealer: Applied at a dry film thickness of not less than 1.0 mil.
 - 3. Sherwin-Williams; PrepRite Masonry Primer B28W300: Applied at a dry film thickness of not less than 3.0 mils.

- B. Interior Gypsum Board Primer: Factory-formulated latex-based primer for interior application.
 - 1. Benjamin Moore; Moorcraft Super Spec Latex Enamel Undercoater & Primer Sealer No. 253: Applied at a dry film thickness of not less than 1.2 mils.
 - 2. Pittsburgh Paints; 6-2 SpeedHide Interior Quick-Drying Latex Sealer: Applied at a dry film thickness of not less than 1.0 mil.
 - 3. Sherwin-Williams; PrepRite 200 Latex Wall Primer B28W200 Series: Applied at a dry film thickness of not less than 1.6 mils.

- C. Interior Wood Primer for Acrylic-Enamel and Semigloss Alkyd-Enamel Finishes: Factory-formulated alkyd- or acrylic-latex-based interior wood primer.
 - 1. Benjamin Moore; Moorcraft Super Spec Alkyd Enamel Underbody and Primer Sealer No. 245: Applied at a dry film thickness of not less than 1.5 mils.
 - 2. Pittsburgh Paints; 6-855 SpeedHide Latex Enamel Undercoater: Applied at a dry film thickness of not less than 1.0 mil.
 - 3. Sherwin-Williams; PrepRite Wall and Wood Primer B49W200 Series: Applied at a dry film thickness of not less than 1.6 mils.
 - 4. Sherwin-Williams; PrepRite Classic Interior Primer B28W101 Series: Applied at a dry film thickness of not less than 1.6 mils.

2.6 EXTERIOR FINISH COATS

- A. Exterior Semigloss Acrylic Enamel: Factory-formulated semigloss waterborne acrylic-latex enamel for exterior application.
 - 1. Benjamin Moore; Moorcraft Super Spec Latex House & Trim Paint No. 170: Applied at a dry film thickness of not less than 1.1 mils.
 - 2. Pittsburgh Paints; 6-900 Series SpeedHide Exterior House & Trim Semi-Gloss Acrylic Latex Paint: Applied at a dry film thickness of not less than 1.5 mils.
 - 3. Sherwin-Williams; A-100 Latex Gloss A8 Series: Applied at a dry film thickness of not less than 1.3 mils.

- B. Exterior Full-Gloss Acrylic Enamel for Ferrous and Other Metals: Factory-formulated full-gloss waterborne acrylic-latex enamel for exterior application.
 - 1. Benjamin Moore; Moore's IMC Acrylic Gloss Enamel M28: Applied at a dry film thickness of not less than 2.0 mils.
 - 2. Pittsburgh Paints; 90-300 Series Pitt-Tech One Pack Interior/Exterior High Performance Waterborne High Gloss DTM Industrial Enamels: Applied at a dry film thickness of not less than 3.0 mils.
 - 3. Sherwin-Williams; DTM Acrylic Coating Gloss (Waterborne) B66W100 Series: Applied at a dry film thickness of not less than 2.4 mils.

2.7 INTERIOR FINISH COATS

- A. Interior Flat Acrylic Paint: Factory-formulated flat acrylic-emulsion latex paint for interior application.

1. Benjamin Moore; Moorecraft Super Spec Latex Flat No. 275: Applied at a dry film thickness of not less than 1.2 mils.
 2. Pittsburgh Paints; 6-70 Line SpeedHide Interior Wall Flat-Latex Paint: Applied at a dry film thickness of not less than 1.0 mil.
 3. Sherwin-Williams; ProMar 200 Interior Latex Flat Wall Paint B30W200 Series: Applied at a dry film thickness of not less than 1.4 mils.
- B. Interior Low-Luster Acrylic Enamel: Factory-formulated eggshell acrylic-latex interior enamel.
1. Benjamin Moore; Moorcraft Super Spec Latex Eggshell Enamel No. 274: Applied at a dry film thickness of not less than 1.3 mils.
 2. Pittsburgh Paints; 6-400 Series SpeedHide Eggshell Acrylic Latex Enamel: Applied at a dry film thickness of not less than 1.25 mils.
 3. Sherwin-Williams; ProMar 200 Interior Latex Egg-Shell Enamel B20W200 Series: Applied at a dry film thickness of not less than 1.6 mils.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Applicator present, for compliance with requirements for paint application. Comply with procedures specified in PDCA P4.
1. Proceed with paint application only after unsatisfactory conditions have been corrected and surfaces receiving paint are thoroughly dry.
 2. Start of painting will be construed as Applicator's acceptance of surfaces and conditions within a particular area.
- B. Coordination of Work: Review other Sections in which primers are provided to ensure compatibility of the total system for various substrates. On request, furnish information on characteristics of finish materials to ensure use of compatible primers.
1. Notify Architect about anticipated problems when using the materials specified over substrates primed by others.

3.2 PREPARATION

- A. General: Remove hardware and hardware accessories, plates, machined surfaces, lighting fixtures, and similar items already installed that are not to be painted. If removal is impractical or impossible because of size or weight of the item, provide surface-applied protection before surface preparation and painting.
1. After completing painting operations in each space or area, reinstall items removed using workers skilled in the trades involved.
- B. Cleaning: Before applying paint or other surface treatments, clean substrates of substances that could impair bond of the various coatings. Remove oil and grease before cleaning.

1. Schedule cleaning and painting so dust and other contaminants from the cleaning process will not fall on wet, newly painted surfaces.
- C. Surface Preparation: Clean and prepare surfaces to be painted according to manufacturer's written instructions for each particular substrate condition and as specified.
1. Provide barrier coats over incompatible primers or remove and reprime.
 2. Cementitious Materials: Prepare concrete, concrete unit masonry, cement plaster, and mineral-fiber-reinforced cement panel surfaces to be painted. Remove efflorescence, chalk, dust, dirt, grease, oils, and release agents. Roughen as required to remove glaze. If hardeners or sealers have been used to improve curing, use mechanical methods of surface preparation.
 - a. Use abrasive blast-cleaning methods if recommended by paint manufacturer.
 - b. Determine alkalinity and moisture content of surfaces by performing appropriate tests. If surfaces are sufficiently alkaline to cause the finish paint to blister and burn, correct this condition before application. Do not paint surfaces if moisture content exceeds that permitted in manufacturer's written instructions.
 - c. Clean concrete floors to be painted with a 5 percent solution of muriatic acid or other etching cleaner. Flush the floor with clean water to remove acid, neutralize with ammonia, rinse, allow to dry, and vacuum before painting.
 3. Ferrous Metals: Clean ungalvanized ferrous-metal surfaces that have not been shop coated; remove oil, grease, dirt, loose mill scale, and other foreign substances. Use solvent or mechanical cleaning methods that comply with SSPC's recommendations.
 - a. Blast steel surfaces clean as recommended by paint system manufacturer and according to SSPC-SP 6/NACE No. 3.
 - b. Treat bare and sandblasted or pickled clean metal with a metal treatment wash coat before priming.
 - c. Touch up bare areas and shop-applied prime coats that have been damaged. Wire-brush, clean with solvents recommended by paint manufacturer, and touch up with same primer as the shop coat.
 4. Galvanized Surfaces: Clean galvanized surfaces with nonpetroleum-based solvents so surface is free of oil and surface contaminants. Remove pretreatment from galvanized sheet metal fabricated from coil stock by mechanical methods.
- D. Material Preparation: Mix and prepare paint materials according to manufacturer's written instructions.
1. Maintain containers used in mixing and applying paint in a clean condition, free of foreign materials and residue.
 2. Stir material before application to produce a mixture of uniform density. Stir as required during application. Do not stir surface film into material. If necessary, remove surface film and strain material before using.
 3. Use only thinners approved by paint manufacturer and only within recommended limits.

- E. Tinting: Tint each undercoat a lighter shade to simplify identification of each coat when multiple coats of same material are applied. Tint undercoats to match the color of the finish coat but provide sufficient differences in shade of undercoats to distinguish each separate coat.

3.3 APPLICATION

- A. General: Apply paint according to manufacturer's written instructions. Use applicators and techniques best suited for substrate and type of material being applied.
 - 1. Paint colors, surface treatments, and finishes are indicated in the paint schedules.
 - 2. Do not paint over dirt, rust, scale, grease, moisture, scuffed surfaces, or conditions detrimental to formation of a durable paint film.
 - 3. Provide finish coats that are compatible with primers used.
 - 4. The term "exposed surfaces" includes areas visible when permanent or built-in fixtures, grilles, convector covers, covers for finned-tube radiation, and similar components are in place. Extend coatings in these areas, as required, to maintain system integrity and provide desired protection.
 - 5. Paint surfaces behind movable equipment and furniture the same as similar exposed surfaces. Before final installation of equipment, paint surfaces behind permanently fixed equipment or furniture with prime coat only.
 - 6. Paint interior surfaces of ducts with a flat, nonspecular black paint where visible through registers or grilles.
 - 7. Paint back sides of access panels and removable or hinged covers to match exposed surfaces.
 - 8. Finish exterior doors on tops, bottoms, and side edges the same as exterior faces.
 - 9. Finish interior of wall and base cabinets and similar field-finished casework to match exterior.
 - 10. Sand lightly between each succeeding enamel or varnish coat.
- B. Scheduling Painting: Apply first coat to surfaces that have been cleaned, pretreated, or otherwise prepared for painting as soon as practicable after preparation and before subsequent surface deterioration.
 - 1. The number of coats and film thickness required are the same regardless of application method. Do not apply succeeding coats until previous coat has cured as recommended by manufacturer. If sanding is required to produce a smooth, even surface according to manufacturer's written instructions, sand between applications.
 - 2. Omit primer over metal surfaces that have been shop primed and touchup painted.
 - 3. If undercoats, stains, or other conditions show through final coat of paint, apply additional coats until paint film is of uniform finish, color, and appearance. Give special attention to ensure that edges, corners, crevices, welds, and exposed fasteners receive a dry film thickness equivalent to that of flat surfaces.
 - 4. Allow sufficient time between successive coats to permit proper drying. Do not recoat surfaces until paint has dried to where it feels firm, and does not deform or feel sticky under moderate thumb pressure, and until application of another coat of paint does not cause undercoat to lift or lose adhesion.

- C. Application Procedures: Apply paints and coatings by brush, roller, spray, or other applicators according to manufacturer's written instructions.
 - 1. Brushes: Use brushes best suited for type of material applied. Use brush of appropriate size for surface or item being painted.
 - 2. Rollers: Use rollers of carpet, velvet-back, or high-pile sheep's wool as recommended by manufacturer for material and texture required.
 - 3. Spray Equipment: Use airless spray equipment with orifice size as recommended by manufacturer for material and texture required.
- D. Minimum Coating Thickness: Apply paint materials no thinner than manufacturer's recommended spreading rate to achieve dry film thickness indicated. Provide total dry film thickness of the entire system as recommended by manufacturer.
- E. Mechanical and Electrical Work: Painting of mechanical and electrical work is limited to items exposed in equipment rooms and occupied spaces.
- F. Block Fillers: Apply block fillers to concrete masonry block at a rate to ensure complete coverage with pores filled.
- G. Prime Coats: Before applying finish coats, apply a prime coat, as recommended by manufacturer, to material that is required to be painted or finished and that has not been prime coated by others. Recoat primed and sealed surfaces where evidence of suction spots or unsealed areas in first coat appears, to ensure a finish coat with no burn-through or other defects due to insufficient sealing.
- H. Pigmented (Opaque) Finishes: Completely cover surfaces as necessary to provide a smooth, opaque surface of uniform finish, color, appearance, and coverage. Cloudiness, spotting, holidays, laps, brush marks, runs, sags, ropiness, or other surface imperfections will not be acceptable.
- I. Transparent (Clear) Finishes: Use multiple coats to produce a glass-smooth surface film of even luster. Provide a finish free of laps, runs, cloudiness, color irregularity, brush marks, orange peel, nail holes, or other surface imperfections.
 - 1. Provide satin finish for final coats.
- J. Stipple Enamel Finish: Roll and redistribute paint to an even and fine texture. Leave no evidence of rolling, such as laps, irregularity in texture, skid marks, or other surface imperfections.
- K. Completed Work: Match approved samples for color, texture, and coverage. Remove, refinish, or repaint work not complying with requirements.

3.4 CLEANING

- A. Cleanup: At the end of each workday, remove empty cans, rags, rubbish, and other discarded paint materials from Project site.
 - 1. After completing painting, clean glass and paint-spattered surfaces. Remove spattered paint by washing and scraping without scratching or damaging adjacent finished surfaces.

3.5 PROTECTION

- A. Protect work of other trades, whether being painted or not, against damage from painting. Correct damage by cleaning, repairing or replacing, and repainting, as approved by Architect.
- B. Provide "Wet Paint" signs to protect newly painted finishes. After completing painting operations, remove temporary protective wrappings provided by others to protect their work.
 - 1. After work of other trades is complete, touch up and restore damaged or defaced painted surfaces. Comply with procedures specified in PDCA P1.

3.6 EXTERIOR PAINT SCHEDULE

- A. Concrete Unit Masonry: Provide the following finish systems over exterior concrete unit masonry:
 - 1. Semigloss Acrylic-Enamel Finish: Two finish coats over a block filler.
 - a. Block Filler: Concrete unit masonry block filler.
 - b. Finish Coats: Exterior semigloss acrylic enamel.
- B. Ferrous Metal: Provide the following finish systems over exterior ferrous metal. Primer is not required on shop-primed items.
 - 1. Full-Gloss Alkyd-Enamel Finish: Two finish coats over a rust-inhibitive primer.
 - a. Primer: Exterior ferrous-metal primer.
 - b. Finish Coats: Exterior full-gloss alkyd enamel.

3.7 INTERIOR PAINT SCHEDULE

- A. Apparatus Bay Concrete Masonry Unit: Provide the following finish systems over interior concrete masonry:
 - 1. Apparatus Bay Walls: (High-Gloss Finish: One finish coat over an intermediate coat and a block filler.
 - a. Block Filler: Acrylic or epoxy block filler applied at spreading rate recommended by manufacturer as sufficient to fill pores.
 - 1) Moore: M88 Latex Block Filler.
 - 2) PPG: 16-90 Pitt-Glaze High Performance Acrylic Latex Block Filler.
 - 3) S-W: Heavy Duty Block Filler B42W46.
 - 4) Tnemec: Latex Masonry Block Filler.
 - b. Intermediate Coat: Acrylic enamel applied at spreading rate recommended by manufacturer to achieve a dry film thickness of 1.0 to 4.0 mils.
 - 1) Moore: M28 Acrylic Gloss Enamel.
 - 2) PPG: 90-3XX Series Pitt-Tech One Pack Interior/Exterior High Performance Waterborne High Gloss DTM Industrial Enamel.
 - 3) S-W: DTM Acrylic Gloss Coating B66W100 Series.
 - 4) Tnemec: Series 28 Tuf-Cryl Water Based Acrylic Emulsion.
 - c. Topcoat: High-gloss acrylic enamel applied at spreading rate recommended by manufacturer to achieve a dry film thickness of 1.0 to 4.0 mils.

- 1) Moore: M28 Acrylic Gloss Enamel.
- 2) PPG: 90-3XX Series Pitt-Tech One Pack Interior/Exterior High Performance Waterborne High Gloss DTM Industrial Enamel.
- 3) S-W: DTM Acrylic Gloss Coating B66W100 Series.
- 4) Tnemec: Series 28 Tuf-Cryl Water Based Acrylic Emulsion.

B. Gypsum Board Walls: Provide the following finish systems over interior gypsum board surfaces:

1. Low-Luster Acrylic-Enamel Finish: Two finish coats over a primer.
 - a. Primer: Interior gypsum board primer.
 - b. Finish Coats: Interior low-luster acrylic enamel.

C. Plaster Gypsum Board Ceilings: Provide the following finish systems over new interior plaster surfaces:

1. Flat Acrylic Finish: Two finish coats over a primer.
 - a. Primer: Interior plaster primer.
 - b. Finish Coats: Interior flat acrylic paint.

D. Ferrous Metal: Provide the following finish systems over ferrous metal:

1. Full-Gloss Alkyd-Enamel Finish: Two finish coats over a primer.
 - a. Primer: Interior ferrous-metal primer.
 - b. Finish Coats: Interior full-gloss alkyd enamel.

E. All-Service Jacket over Insulation: Provide the following finish system on cotton or canvas insulation covering:

1. Flat Acrylic Finish: Two finish coats. Add fungicidal agent to render fabric mildew proof.
 - a. Finish Coats: Interior flat latex-emulsion size.

3.8 INTERIOR STAIN AND NATURAL-FINISH WOODWORK SCHEDULE

A. Stained Woodwork: Provide the following stained finishes over new interior woodwork:

1. Alkyd-Based Stain Satin-Varnish Finish: Two finish coats of alkyd-based clear satin varnish over a sealer coat and interior wood stain. Wipe wood filler before applying stain.
 - a. Filler Coat: Open-grain wood filler.
 - b. Stain Coat: Interior wood stain.
 - c. Sealer Coat: Clear sanding sealer.
 - d. Finish Coats: Interior alkyd- or polyurethane-based clear satin varnish.

B. Natural-Finish Woodwork: Provide the following natural finishes over new interior woodwork:

1. Alkyd-Based Satin-Varnish Finish: Two finish coats of alkyd-based clear satin varnish over a sanding sealer. Provide wood filler on open-grain wood before applying first varnish coat.

- a. Filler Coat: Open-grain wood filler.
- b. Sealer Coat: Clear sanding sealer.
- c. Finish Coats: Interior alkyd- or polyurethane-based clear satin varnish.

END OF SECTION 099100

SECTION 099700 - SPECIAL COATINGS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to the work of this section.

1.2 SUMMARY

- A. Work covered by this Section includes the furnishing and application of paints, stains, primers, varnishes and other finish, decorative and protective coatings.
- B. Shop priming and factory prefinishing are required on some, but not necessarily all, of the items described in other sections.
- C. Extent of work:
 - 1. All new process equipment and process piping.
 - 2. All conduits, ducts, drains, etc of other trades unless such product is deemed having an acceptable factory pre-finish, under the following conditions:
 - a. When specifically called out as requiring special coating protection.
 - 3. All ferrous metal process equipment, ferrous metal process piping, bridges, and all other interior ferrous metal within the final clarifiers and sludge thickeners.
 - 4. Interior masonry and concrete wall surfaces.

1.3 DEFINITIONS

- A. Special coating systems are defined as those types of materials and methods of application requiring more than normal skills and techniques for mixing, handling and application, as specified in the "Painting" section.
 - 1. The term "special coating systems" as used in this section includes applied materials used in prime, intermediate and finish coats.
 - 2. The word "paint", as applied in this and or other Sections shall apply to all special coatings required herein for the protection of materials from corrosive environment, weathering processes, or for aesthetic or other reasons.
 - 3. The term "exposed surfaces" is defined to include areas visible when permanent or built-in fixtures, convector covers, covers for finned tube radiation, grilles, and similar components are in place in areas to be coated. Extend special coatings in these areas as required to maintain the coating system integrity and provide desired protection.

1.4 SUBMITTALS

- A. Product Data: Submit manufacturer's technical information including basic materials analysis and application instructions for each coating material specified.
 - 1. List each material and cross-reference to the specific coating and finish system and application. Identify each material by the manufacturer's catalog number and general classification.

2. In the event that the submittal requests a substitution then the following ASTM test results from an independent testing laboratory for the referenced products shall be included the following Performance Criteria:
 - a. ASTM B 117 Salt Fog
 - b. ASTM D 3359 (Method A and B) Adhesion Test
 - c. ASTM G8, Method A Cathodic Disbondment
 - d. ASTM D 4541 (Elcometer)
 - e. ASTM D 4060 Taber Abrasion
 - f. ASTM D 522 (Conical Mandrel)
 - g. ASTM D 3363 Pencil Hardness
 - h. ASTM D 2794 Impact
 - i. ASTM G 53 QUV Exposure
 - j. ASTM D 2240 Durometer, Shore D
 - k. ASTM D 870 Immersion (Potable Water)
 - l. ASTM E 96 Moisture Vapor Transmission
 - m. ASTM D 2370 Tensile Strength and Elongation
 - n. ASTM D 638 Tear Strength
- B. Manufacturer's representative color and texture sample cards shall be submitted to the Engineer at least 30 days prior to paint application. Contractor shall coordinate work so as to allow sufficient time for paint to be delivered to the job site.

1.5 QUALITY ASSURANCE

- A. Single Source Responsibility: Provide primers and other undercoat material produced by the same manufacturer as the finish coats. Use only thinners recommended by the manufacturer, and only within recommended limits.
- B. Coordination of Work: Review other sections of these specifications in which other coatings are to be provided to ensure compatibility of the total coatings systems for various substrates.
 1. Upon request, furnish information on the characteristics of pre-primed materials, to ensure that provisions for specified finish coats can be appropriately applied.
 2. Notify the Engineer of any anticipated problems involved in using the coatings systems as specified.
 3. Verify colors with Owner.
- C. Job Mock-up:
 1. Minimum 50 sq. ft.. application of each specified coating system on each type of substrate. At Engineer's discretion.
 2. Mock-ups will serve as standard for acceptance of work.
 3. Leave approved mock-ups in place as part of completed project.
 4. Manufacturer's representative shall be available to advise applicator on proper application techniques and procedures.

1.6 DELIVERY, STORAGE AND HANDLING

- A. Deliver materials to the job site in the manufacturer's original, new, unopened packages and containers bearing manufacturer's name and label and the following information:
 1. Name or title of material.

2. Federal Specification number, if applicable.
 3. Manufacturer's stock number and date of manufacture.
 4. Manufacturer's name.
 5. Contents by volume, for major pigment and vehicle constituents.
 6. Thinning instructions.
 7. Application instructions.
 8. Color name and number.
 9. Handling instructions and precautions.
- B. Store materials not in actual use in tightly covered containers at a minimum ambient temperature of 45 deg. F (7 deg. C) in a well-ventilated area. Maintain containers used in storage of coatings in a clean condition, free of foreign materials and residue.
1. Protect from freezing where necessary. Keep storage area neat and orderly. Remove oily rags and waste daily. Take all necessary precautionary measures to ensure that workmen and work areas are adequately protected from fire hazards and health hazards resulting from handling, mixing and application of stains.

1.7 PROJECT CONDITIONS

- A. Apply coatings only when the temperature of surfaces to be coated and surrounding air temperatures are above 45 deg. F (7 deg. C), unless otherwise permitted by manufacturer's printed instructions.
- B. Do not apply coatings in snow, rain, fog or mist, or when the relative humidity exceeds 85%, or to damp or wet surfaces unless otherwise permitted by manufacturer's printed instructions. Allow wet surfaces to dry thoroughly and attain the temperature and conditions specified before proceeding with or continuing with the coating operation.
1. Work may continue during inclement weather only if areas and surfaces to be coated are enclosed and the temperature within the area can be maintained within limits specified by the manufacturer during application and drying periods.
- C. Report to responsible person such as safety personnel, General Trades Superintendent, etc., any condition which may pose a threat to the health and welfare of employees.
- D. Keep working area clean and safe.
- E. Obey all job site rules and regulations.
- F. Surfaces not to be painted; unless specifically stated otherwise:
1. Face brick
 2. Pre-finished wall panels, partitions and ceiling tile
 3. Items with acceptable factory-applied final finish
 4. Concealed ducts, pipes and conduit.
 5. Glass, Aluminum, Copper, Bronze, Stainless Steel

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products of one of the following:
1. Tnemec Company, Inc., North Kansas City, Missouri, represented by Design Coatings, Moon Township, Pennsylvania (800) 356-3041
 2. Carboline, 2150 Schuetz Road, St.Louis, MO, (800) 848-4645.

2.2 COATING SYSTEMS

A. Ferrous Metal:

1. Submerged, Non-Potable

Surface Preparation: SSPC-SP10 Near White Blast

First Coat: Tnemec Series N69 Hi-Build Epoxoline II @ 4.0-6.0 mils dry
Carboline Carboguard 635 @ 3.0 – 5.0 DFT.

Stripe Coat: Tnemec Series N69 Hi-Build Epoxoline II @ 2.0 – 3.0 mils dry
Carboline Carboguard 635 @ 3.0 – 5.0 DFT.

Second Coat: Tnemec Series N69 Hi-Build Epoxoline II @ 6.0-8.0 mils dry
Carboline Carboguard 890 @ 4.0 – 6.0 DFT.

NOTE: If shop primed, field surface preparation for weld seams and abraded areas is SSPC-SP-10 and spot prime with Series N-69 Hi-Build Epoxoline II @ 4.0-6.0 mils dry or Carboline Carboguard 635 @ 3.0 – 5.0 DFT.. Stripe coat is a brush or roller coat on all edges or welds.

2. Submerged, Potable

Surface Preparation: SSPC-SP10 Near White Blast

First Coat: Tnemec Series FC20 Tneme-Fascure @ 4.0-6.0 mils dry
Carboline Carboguard 891 @ 4.0 – 6.0 DFT.

Second Coat: Tnemec Series N140 Pota-Pox Plus @ 6.0-8.0 mils dry
Carboline Carboguard 891 @ 6.0 – 10.0 DFT.

NOTE: If shop primed, field surface preparation for weld seams and abraded areas are SSPC-SP-10 and spot prime with Tnemec Series FC20 @ 3-5 mils dry or Carboline Carboguard 891@ 3-5 mils dry.

3. Non-Submerged, Interior Exposure

Surface Preparation: SSPC-SP6 Commercial Blast

First Coat: Tnemec Series 161 Tneme-Fascure @ 3.0-5.0 mils dry
Carboline Carboguard 635 @ 3.0 – 5.0 DFT.

Second Coat: Tnemec Series N69 Hi-Build Epoxoline II @ 4.0-6.0 mils dry
Carboline Carboguard 890 @ 4.0 – 6.0 DFT.

NOTE: If shop primed, field surface preparation for weld seams and abraded areas is SSPC-SP-10 and spot prime with Tnemec Series 161 @ 3-5 mils dry or Carboline Carboguard 635 @ 3.0 – 5.0 DFT..

4. Non-Submerged, Exterior Exposure

Surface Preparation: SSPC-SP6 Commercial Blast

First Coat: Tnemec Series 161 Tneme-Fascure @ 3.0-5.0 mils dry
Carboline Carboguard 635 @ 3.0 – 5.0 DFT.

Second Coat: Tnemec Series 1075 Endura-Shield II @ 2.0-4.0 mils dry

Carboline Carbothane 133 LH @ 3.0 – 5.0 DFT.

NOTE: If shop primed, field surface preparation for weld seams and abraded areas is SSPC-SP-6 and spot prime with Tnemac Series 161 @ 3-5 mils dry or Carboline Carboguard 635 @ 3.0 – 5.0 DFT..

5. Galvanized Steel (including Bar Joist and Galvanized Steel)
Surface Preparation: SSPC-SPI Solvent Clean on galvanized surfaces.
SSPC-SP7 Brush-Off blast to lightly profile surface.
First Coat: Tnemac Series 161 Tneme-Fascure @ 3.0-4.0 mils dry
Carboline Carboguard 888 @ 3.0 – 4.0 DFT.

B. Non-Ferrous Metals:

1. Interior Exposure
Surface Preparation: SSPC-SP1 Solvent Clean and Scarify per SSPC-SP 3
First Coat: Tnemac Series 161 Tneme-Fascure @ 2.0-3.0 mils dry
Caroline Carboguard 635 @ 3.0 – 5.0 DFT.
Second Coat: Tnemac Series 161 Tneme-Fascure @ 3.0-5.0 mils dry
Carboline Carboguard 635 @ 3.0 – 5.0 DFT.
2. Exterior Exposure
Surface Preparation: SSPC-SP1 Solvent Clean and Scarify per SSPC-SP 3
First Coat: Tnemac Series 161 Tneme-Fascure @ 2.0-3.0 mils dry
Carboline Carboguard 635 @ 3.0 – 5.0 DFT.
Second Coat: Tnemac Series 1075 Endura-Shield @ 2.0-4.0 mils dry
Carboline Carbothane 133 LH @ 3.0 – 5.0 DFT.

C. Concrete

1. Submerged, Non-Potable
Surface Preparation: SSPC-SP 13/NACE#6 "Surface Preparation of Concrete"
First Coat: Tnemac Series N69 Hi-Build Epoxoline II @ 150 sq. ft./gal.
Carboline Carboguard 890 @ 150 sq. ft./gal.
Second Coat: Tnemac Series N69 Hi-Build Epoxoline II @ 150 sq. ft./gal.
Carboline Carboguard 890 @ 150 sq. ft./gal.
2. Waterproofing - See Specification Section 09880
3. Non-submerged, poured in place or precast, Interior Exposure
Surface Preparation: Clean and dry
First Coat: Tnemac Series N69 Hi-Build Epoxoline II @ 150 sq. ft./gal.
Carboline Carboguard 890 @ 150 sq. ft./gal.
Second Coat: Tnemac Series N69 Hi-Build Epoxoline II @ 150 sq. ft./gal.
Carboline Carboguard 890 @ 150 sq. ft./gal.
4. Non-submerged, poured in place or precast, Exterior Exposure
Surface Preparation: Clean and dry
First Coat: Tnemac Series 156 Envirocrete @ 150 sq. ft./gal.
Carboline Flexside Elastomer @ 150 sq. ft./gal.
Second Coat: Tnemac Series 156 Envirocrete @ 150 sq. ft./gal.
Carboline Flexside Elastomer @ 150 sq. ft./gal.
5. Concrete block walls, Interior Exposure
Surface Preparation: Clean and dry

- | | |
|--------------|--|
| First Coat: | Tnemac Series 130-6601 Envirofill @ 75 sq. ft.. per gal. or Carboline Sanitile 100@ 75 sq. ft./gal. Material should be rolled, or sprayed and back rolled, then squeegeed to provide a smoother surface. |
| Second Coat: | Tnemac Series N69 Hi-Build Epoxoline II @150 sq. ft./gal.
Carboline Carboguard 890 @ 150 sq. ft./gal. |
| Third Coat: | Tnemac Series N69 Hi-Build Epoxoline II @150 sq. ft./gal.
Carboline Carboguard 890 @ 150 sq. ft./gal. |
6. Concrete block walls, Exterior Exposure
- | | |
|----------------------|---|
| Surface Preparation: | Clean and dry |
| First Coat: | Tnemac Series 156 Envirocrete @ 100 sq. ft./gal.
Carboline Flexside Elastomer @ 100 sq. ft./gal. |
| Second Coat: | Tnemac Series 156 Envirocrete @ 100 sq. ft./gal.
Carboline Flexside Elastomer @ 100 sq. ft./gal. |
7. Floors
- | | |
|----------------------|--|
| Surface Preparation: | SSPC-SP 13/NACE#6 "Surface Preparation of Concrete" |
| First Coat: | Tnemac Series 203 Epoxoprime LV @ 250 sq. ft./ gal.
Carboline Carbotguard 1340 @ 3.0 – 4.0 DFT. |
| Second Coat: | Tnemac Series 280 Tneme-Glaze @ 150 sq. ft./gal.
If non-skid is desired, then randomly broadcast with 30/50 mesh silica sand into wet epoxy intermediate
Carboline Semstone 140 W 6.0 – 8.0 DFT. |
| Third Coat: | Tnemac Series 291 CRU @ 250 sq. ft./gal.
Carboline Sanitile 865 @ 2.0 – 3.0 DFT. |
8. Foundations
- | | |
|----------------------|--|
| Surface Preparation: | Clean and dry |
| First Coat: | Tnemac Series 46H413 80 sq. ft./gal.
Carboline Bitumastic 300 M @ 80 sq. ft./gal. |
- D. PVC Pipe
- | | |
|----------------------|--|
| Surface Preparation: | Lightly sand |
| First Coat: | Tnemac Series 161 Tneme-Fascure @ 200 sq. ft./gal.
Carboline Carboguard 893 SG @ 200 sq. ft./gal. |
- E. Insulated Pipe
- | | |
|----------------------|---|
| Surface Preparation: | Clean and dry |
| First Coat: | Tnemac Series 29 Tuf-Cryl @ 300 sq. ft./gal.
Carboline Carbocrylic 3350 @ 300 sq. ft./gal. |
| Second Coat: | Tnemac Series 29 Tuf-Cryl @ 300 sq. ft./gal.
Carboline Carbocrylic 3350 @ 300 sq. ft./gal. |
- F. Insulated Pipe
- | | |
|----------------------|---|
| Surface Preparation: | Clean and dry |
| First Coat: | Tnemac Series 27 F.C. Typoxy @ 400 sq. ft./gal.
Carboline Carboguard 888 @ 400 sq. ft./gal. |
| Second Coat: | Tnemac Series 113 Tneme-Tufcoat @ 325 sq. ft./gal.
Carboline Sanitile 255 @ 325 sq. ft./gal. |

2.3 COLOR CODING AND PROCESS SYSTEM IDENTIFICATION

- A. Color coding for processing piping, equipment and appurtenances is a suggested system unless otherwise specified or requested by owner. Final coding to be determined in the field:
1. Equipment - light gray with O.S.H.A. orange coupling guards and O.S.H.A. yellow belt guards.
 2. Pipe Supports - hangers to be same color as piping applied, floor post to be same as adjacent wall color, and fabricated racks to be manufacturer's standard protective finish or paint same as adjacent wall color if not having a suitable protective finish.
 3. Process piping-exposed interior or exterior:
 - a. Submerged Pipe or Supports - Black
 - b. Intermittently Submerged Metals - Black (unless piping as defined otherwise)
 - c. Natural Gas - OSHA Red*
 - d. Process/L.P. Gas - OSHA Orange
 - e. Potable (City) water - OSHA Blue*
 - f. Well or Non-Potable Water – Aqua
 - g. Seal water, wash water – white plant effluent
 - h. Raw wastewater - Brown
 - i. Equipment drains - Black
 - j. Sanitary drains - Black with tags
 - k. Chemical feed - Aqua
 - l. Vents- Green
 - m. Compressed air - Green
 - n. Raw Sewage - Brown
 - o. Grit - Brown
 - p. Return Sludge - Brown
 - q. Waste Sludge or Liquor - Brown
 - r. Supernatant - OSHA Green
 - s. Fuel Oil - Dark Gray
 - t. Sample Lines - Light Blue
 - u. Fire Protection System - OSHA Red Sprinkler Piping
 - v. Hoist and Trolleys - OSHA Yellow

* These colors are recommended as standard by WPCF.
 4. Miscellaneous, non-process related items such as electrical conduit, duct work, roof drains, etc. are to be properly prepped and finished to match adjacent wall or ceiling color in rooms scheduled for finish wall and/or ceiling paint.
- B. Signs and Labels
1. There shall be stenciled on each pipeline in each room a minimum of two legends describing the function of the pipeline, such as "natural gas", on each side of the pipe. It is intended that all pipelines shall bear legend at the most visible point and meet ANSI A13.1 Scheme for the identification of piping system for size, type and vantage point of legends.
 2. Signs shall be furnished and securely fastened to each pipeline showing its destination such as "Aeration Tank No. 1."
 3. Where the flow of a pipeline is in one direction only, then a flow arrow shall be stenciled in front of each legend on the pipe.
 4. For pipes smaller than 1 in. in outside diameter, a white plastic tag with black lettering shall be used.
 5. The legends and flow arrows shall be stenciled with approved stencil paint. Following the completion of other work under this Item, all stencils used shall remain the property of the Owner.

6. Each hydrant, hose bib, sillcock, and yard hydrant connected to plant water shall be stenciled with the words "Unsafe Water - Do Not Drink". The size of the stenciled letters shall be 1 inch. Stencil on the hydrants is to be on the nozzle section. The hose bibs shall have a 15" x 5" x 1/2" thick plaque made of marine plywood, where the stenciled letters are to be applied. The Plaque shall be fastened to the structure directly above the hose bib connection, (Plaques to have white letters with aqua background).
7. Preprinted plastic-coated adhesive labels may be used in lieu of stencils, on interior piping only.
8. All rooms in which equipment is operated automatically shall have signs mounted on the walls which are visible at entrances. The Contractor shall furnish twenty 14 in. x 20 in. black or yellow porcelain signs meeting OSHA requirements. Signs shall include mounting accessories. Each sign shall read:

“Warning: The equipment in this room operates automatically and may start or stop at any time.”

PART 3 - EXECUTION

3.1 PRE-WORK INSPECTION

- A. Examine surfaces to be coated and report conditions that would adversely affect appearance or performance of coating systems and which cannot be put into an acceptable condition by preparatory work specified in Paragraph 3.02.
- B. Do not proceed with surface preparation and application until surface is acceptable or authorization to proceed is given by the Owner's representative.

3.2 SURFACE PREPARATION

- A. General:
 1. Dislodge dirt, rust, plaster nibs, mortar spatter and other dry material by scraping or brushing. Remove dust and loose material by brushing, sweeping, vacuuming or blowing with high-pressure air.
 2. Remove oil, wax and grease by scraping off heavy deposits and cleaning with mineral spirits or a hot trisodium phosphate solution followed by a water rinse.
 3. Verify that surfaces to be coated are dry, clean and free of dust, dirt, oil, wax grease or other contaminants.
- B. Non-Submerged Concrete, Masonry and Cement Stucco:
 1. Allow new concrete and masonry to cure 28 days
 2. Scrape and grind fins and protrusions flush with surface.
 3. Patch holes and cracks flush with surface.
 4. Rake mortar joints clean.
- C. Plaster:
 1. Allow to cure for 28 days.
 2. Remove nibs and other protrusions by scraping flush with surface.
 3. Patch voids and cracks with spackling compound to match texture or surface.

- D. Gypsum Board:
1. Sand joint compound smooth and flush with surface using fine grit sand paper.
 2. Fill nicks, scratches, holes and uneven spots with spackling compound and after dry, sand flush with surface.
- E. Non-Ferrous Metal:
1. SSPC-SPI solvent cleaning to remove all contaminants.
- F. Ferrous Metal:
1. Enclosed: Remove loose rust, mill scale and other foreign matter by hand (SSPC-SP2) or power tool (SSPC-SP3) cleaning and apply specified coating before rusting occurs.
 2. Non-Submerged, Architecturally Exposed: Society of Protective Coatings, SSPC-SP6 Commercial Blast.
 3. Submerged Steel: Society of Protective Coatings, SSPC-SP10 Near White Blast.
- G. Galvanized Metal:
1. Remove contaminants and protective mill coating by SSPC-SP1 Solvent Cleaning or steam cleaning. All surfaces shall be prepared by light brush blasting to achieve a minimum 1.0 mil abrasive blast profile.
- H. Wood:
1. Remove surface deposits of sap and pitch by scraping and cleaning with mineral spirits.
 2. Seal knots and pitch pockets with a product manufactured for this specific purpose.
 3. Sand rough spots of smooth siding and finish woodwork.
 4. After prime coat is dry, fill cracks, holes and scratches with suitable wood filler or spackling compound and when dry, sand flush with surface.
 5. Sand lightly between coats.
- I. Concrete Floors:
1. Prepare concrete floors in accordance with SSPC-SP 13/NACE #6 "Surface Preparation of Concrete."
- J. Submerged Concrete:
1. Prepare in accordance with SSPC-SP 13/NACE #6 "Surface Preparation of Concrete" to remove laitance and expose all cavities and honeycombs. If immersion service condition will have an exposure outside of neutral pH (6-9) then all cavities shall be filled using Tnemec Series 218 Mortarclad or Carboline Carboguard 510/501. Product is trowel applied to all vertical walls with exposed cavities.
- K. Specific Preparation for the Clarifiers and Sludge Thickeners:
1. All non-metal materials are to be removed from the clarifiers and sludge thickeners prior to sandblasting. Note the materials in 1.7 F that are not to be painted. These materials may need to be protected from the sandblasting. The fiberglass weirs and launders will need to be protected. If there is aluminum grating on the bridges it will need to be unbolted and removed prior to sandblasting and painting. The sludge well may need to be covered before sandblasting to prevent sand from accumulating in the well. All mechanical parts are to be sealed and protected from sandblasting. The Contractor is to coordinate with the Wheeling WWTP the draining of the clarifiers and sludge removal. The

Contractor is responsible for the removal of all sand and debris after sandblasting and is responsible for any additional cleaning needed for surface preparation.

3.3 APPLICATION

- A. General: Apply special coatings by brush, roller, spray, squeegee, or other applicators in accordance with the manufacturer's directions. Use brushes best suited for the type of material being applied. Use rollers of carpet, velvet back, or high-pile sheep's wool as recommended by the manufacturer for the material and texture required.
 - 1. Coating colors, surfaces treatments and finishes are indicated in the "Schedules" of the contract documents.
 - 2. Provide finish coats that are compatible with the primers used.
 - 3. The number of coats and coating film thickness required is the same regardless of the application method. Do not apply succeeding coats until the previous coat has cured as recommended by the coating manufacturer. Sand between coating applications where sanding is required to produce an even smooth surface in accordance with the coating manufacturer's directions.
 - 4. Coat surfaces behind movable equipment and furniture the same as similar exposed surfaces.
 - 5. Coat the back sides of access panels, removable or hinged covers, and similar hinged items, to match exposed surfaces.
- B. Minimum Coating Thickness: Apply each material at not thinner than the manufacturer's recommended spreading rate. Provide a total dry film thickness of the entire coating system as recommended by the manufacturer.
- C. Prime Coats: Before the application of finish coats, apply a prime coat, as recommended by the coating manufacturer, to material that is required to be painted or finished, and which has not been prime coated by others.
 - 1. Recoat primed and sealed substrates where there is evidence of suction spots or unsealed areas in the first coat, to assure a finish coat with no burn-through or other defects due to insufficient sealing.
- D. Brush Application: Brush-out and work brush coats into surfaces in an even film. Eliminate cloudiness, spotting, holidays, laps, brush marks, runs, sags, ropiness, or other surface imperfections. Neatly draw glass lines and color breaks.
 - 1. Apply primers and first coats by brush unless the manufacturer's instructions permit use of mechanical applicators.
- E. Mechanical Applications: Use mechanical methods for coating application when permitted by the coating manufacturer's recommendations, governing ordinances, and trade union regulations.
 - 1. Wherever spray application is used, apply each coat to provide the equivalent hiding of brush-applied coats. Do not double-back with spray equipment building-up film thickness of 2 coats in one pass, unless recommended by the coating manufacturer.
- F. Completed Work: Match approved samples for color, texture and coverage. Remove, refinish or recoat work not in compliance with specified requirements.

3.4 INSPECTION

- A. Request acceptance of each coat before applying succeeding coats.
- B. The Contractor shall furnish the Engineer a suitable thickness detector of a type recommended by the paint manufacturer.
- C. Any field painting found to be defective shall be removed and the surfaces repainted as the Engineer may direct at no additional cost to the Owner.
- D. Before final approval of the work, all damaged surfaces of paint (field or factory applied) shall be cleaned and repainted or touched up as directed.

3.5 FIELD QUALITY CONTROL

- A. The Owner reserves the right to invoke the following material testing procedure at any time, and at any number of times during the period when coating operations are being conducted.
 - 1. The Owner will engage the services of an independent testing laboratory to sample the coating being used. Samples of material delivered to project site will be taken, identified and sealed, and certified in the presence of the Contractor.
 - 2. The testing laboratory will perform appropriate tests for any or all of the following characteristics as required by the Owner:
 - a. Quantitative materials analysis
 - b. Absorption
 - c. Accelerated weathering
 - d. Accelerated yellowness
 - e. Color retention
 - f. Alkali resistance
 - g. Mildew resistance
 - h. Abrasion resistance
 - i. Apparent reflectivity
 - j. Washability
 - k. Dry Opacity
 - l. Recoating
 - m. Skinning
 - 3. If test results show materials being used do not comply with specified requirements, the Contractor may be directed to stop work, and remove non-complying materials, pay for testing, recoat surfaces coated with rejected materials, or remove rejected materials from previously coated surfaces if, upon recoating with the specified materials, the two coatings are not compatible.

3.6 CLEANING

- A. Clean-Up: At the end of each work day during progress of work, remove rubbish, empty cans, rags and other discarded materials from the site.
 - 1. Upon completion of the work, clean window glass and other spattered surfaces. Remove spattered coatings by washing, scraping or other proper methods, using care not to scratch or otherwise damage adjacent finished surfaces.

3.7 PROTECTION

- A. Protect work of other trades, whether to be coated or not, against damage from coating operations. Correct damage by cleaning, repairing or replacing, and recoating as acceptable to the Architect. Leave the work in an undamaged condition.
- B. Provide "Wet Paint" signs as required to protect newly-coated finishes. Remove temporary protective wrappings provided by others for protection of their work, after completion of coating operations.
 - 1. At completion of the work of other trades, touch-up and restore damaged or defaced coated surfaces.

END OF SECTION 099700

SECTION 101423.16 - ROOM-IDENTIFICATION PANEL SIGNAGE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification Sections, apply to work of this section.

1.2 SUMMARY

- A. Section includes room-identification signs that are directly attached to the building.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: For room-identification signs.
 - 1. Include fabrication and installation details and attachments to other work.
 - 2. Show sign mounting heights, locations of supplementary supports to be provided by other installers, and accessories.
 - 3. Show message list, typestyles, graphic elements, including raised characters and Braille, and layout for each sign at least half size.
- C. Samples for Initial Selection: For each type of sign assembly, exposed component, and exposed finish.
- D. Product Schedule: For room-identification signs. Use same designations indicated on Drawings or specified.

1.4 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For signs to include in maintenance manuals.

1.5 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials, from the same product run, that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Variable Component Materials: 12 replaceable text inserts and interchangeable characters (letters, numbers, and graphic elements) of each type.
 - 2. Tools: One set(s) of specialty tools for assembling signs and replacing variable sign components.

1.6 QUALITY ASSURANCE

- A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer.

1.7 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace components of signs that fail in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Deterioration of finishes beyond normal weathering.
 - b. Deterioration of embedded graphic image.
 - c. Separation or delamination of sheet materials and components.
 - 2. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Accessibility Standard: Comply with applicable provisions in ICC A117.1.

2.2 SIGN MATERIALS

- A. Acrylic Sheet: ASTM D4802, category as standard with manufacturer for each sign, Type UVF (UV filtering).
- B. Vinyl Film: UV-resistant vinyl film with pressure-sensitive, permanent adhesive; die cut to form characters or images as indicated on Drawings.
- C. Paints and Coatings for Sheet Materials: Inks, dyes, and paints that are recommended by manufacturer for optimum adherence to surface and are UV and water resistant for colors and exposure indicated.

2.3 ACCESSORIES

- A. Fasteners and Anchors: Manufacturer's standard as required for secure anchorage of signs, noncorrosive and compatible with each material joined, and complying with the following:
 - 1. Use concealed fasteners and anchors unless indicated to be exposed.
 - 2. For exterior exposure, furnish stainless-steel devices unless otherwise indicated.
 - 3. Exposed Metal-Fastener Components, General:
 - a. Fabricated from same basic metal and finish of fastened sign unless otherwise indicated.
 - 4. Sign Mounting Fasteners:

- a. Concealed Studs: Concealed (blind), threaded studs welded or brazed to back of sign material or screwed into back of sign assembly unless otherwise indicated.
- b. Through Fasteners: Exposed metal fasteners matching sign finish, with type of head indicated, and installed in predrilled holes.

B. Adhesive: As recommended by sign manufacturer.

2.4 FABRICATION

A. General: Provide manufacturer's standard sign assemblies according to requirements indicated.

1. Preassemble signs and assemblies in the shop to greatest extent possible. Disassemble signs and assemblies only as necessary for shipping and handling limitations. Clearly mark units for reassembly and installation; apply markings in locations concealed from view after final assembly.
2. Mill joints to a tight, hairline fit. Form assemblies and joints exposed to weather to resist water penetration and retention.
3. Conceal connections if possible; otherwise, locate connections where they are inconspicuous.
4. Provide rabbets, lugs, and tabs necessary to assemble components and to attach to existing work. Drill and tap for required fasteners. Use concealed fasteners where possible; use exposed fasteners that match sign finish.

B. Subsurface-Applied Graphics: Apply graphics to back face of clear face-sheet material to produce precisely formed image. Image shall be free of rough edges.

2.5 GENERAL FINISH REQUIREMENTS

A. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

B. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General: Install signs using mounting methods indicated and according to manufacturer's written instructions.

1. Install signs level, plumb, true to line, and at locations and heights indicated, with sign surfaces free of distortion and other defects in appearance.
2. Install signs so they do not protrude or obstruct according to the accessibility standard.
3. Before installation, verify that sign surfaces are clean and free of materials or

debris that would impair installation.

B. Accessibility: Install signs in locations on walls according to the accessibility standard.

C. Mounting Methods:

1. Concealed Studs: Using a template, drill holes in substrate aligning with studs on back of sign. Remove loose debris from hole and substrate surface.
 - a. Masonry Substrates: Fill holes with adhesive. Leave recess space in hole for displaced adhesive. Place sign in position and push until flush to surface, embedding studs in holes. Temporarily support sign in position until adhesive fully sets.
 - b. Thin or Hollow Surfaces: Place sign in position and flush to surface, install washers and nuts on studs projecting through opposite side of surface, and tighten.
2. Through Fasteners: Drill holes in substrate using predrilled holes in sign as template. Countersink holes in sign if required. Place sign in position and flush to surface. Install through fasteners and tighten.
3. Adhesive: Clean bond-breaking materials from substrate surface and remove loose debris. Apply linear beads or spots of adhesive symmetrically to back of sign and of suitable quantity to support weight of sign after cure without slippage. Keep adhesive away from edges to prevent adhesive extrusion as sign is applied and to prevent visibility of cured adhesive at sign edges. Place sign in position, and push to engage adhesive. Temporarily support sign in position until adhesive fully sets.

3.2 ADJUSTING AND CLEANING

- A. Remove and replace damaged or deformed signs and signs that do not comply with specified requirements. Replace signs with damaged or deteriorated finishes or components that cannot be successfully repaired by finish touchup or similar minor repair procedures.
- B. Remove temporary protective coverings and strippable films as signs are installed.
- C. On completion of installation, clean exposed surfaces of signs according to manufacturer's written instructions, and touch up minor nicks and abrasions in finish. Maintain signs in a clean condition during construction and protect from damage until acceptance by Owner.

END OF SECTION 101423.16

SECTION 102116.19 - PLASTIC SHOWER AND DRESSING COMPARTMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification Sections, apply to work of this section.

1.2 SUMMARY

- A. Section Includes:

- 1. Solid-plastic shower and dressing compartments.

- B. Related Requirements:

- 1. Section 061000 "Rough Carpentry" for blocking.
- 2. Section 092216 "Non-Structural Metal Framing" for blocking.
- 3. Section 102800 "Toilet, Bath, and Laundry Accessories" for accessories mounted on toilet compartments.
- 4. Section 224223 "Commercial Showers" for shower heads, valves, and receptors.

1.3 COORDINATION

- A. Coordinate requirements for overhead supports, blocking, reinforcing, and other supports concealed within wall and ceiling to ensure that compartments can be supported and installed as indicated.

1.4 ACTION SUBMITTALS

- A. Product Data:

- 1. Solid-plastic shower and dressing compartments.
 - a. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.

- B. Samples for Initial Selection: Manufacturer's standard color sheets, showing full range of available finishes for each type of compartment.

- 1. Include Samples of hardware and accessories involving material and color selection.

- C. Samples for Verification: Actual sample of finished product for each type of compartment, hardware, and accessory.

- 1. Size: 36"x36".

- D. Delegated Design Submittals: For grab bars, shower seats, and accessible benches mounted on compartment panels, including analysis data signed and sealed by the

qualified professional engineer responsible for their preparation.

1. Include structural design calculations indicating compliance with specified structural-performance requirements.

1.5 INFORMATIONAL SUBMITTALS

- A. Delegated design engineer qualifications.

1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For shower and dressing compartments.

1.7 MAINTENANCE MATERIAL SUBMITTALS

- A. Extra Stock Material: Furnish extra materials to Owner that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 1. Clothing Hook: One clothing hook(s) with associated fasteners.
 2. Curtain Rod: One curtain rod(s) with associated fasteners.
 3. Curtain Hooks: Five curtain hooks.

1.8 QUALITY ASSURANCE

- A. Delegated Design Engineer Qualifications: A professional engineer who is legally qualified to practice in state where Project is located and who is experienced in providing engineering services of the type indicated.

1.9 FIELD CONDITIONS

- A. Field Measurements: Verify actual locations of fixtures, drains, walls, columns, ceilings, and other construction contiguous with shower and dressing compartments by field measurements, and coordinate before fabrication.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Fire Performance: Tested in accordance with, and pass the acceptance criteria of, NFPA 286, by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
- B. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to provide structural design calculations for grab bars, shower seats, or seats of accessible benches mounted on shower or dressing compartment panels.

- C. Structural Performance: Where grab bars, shower seats, or accessible benches are mounted on shower or dressing compartment panels, design panels to comply with the following requirements:
 - 1. Panels are able to withstand a concentrated load on grab bar, shower seat, or seat of accessible bench of at least 250 lbf applied at any direction and at any point, without deformation of panel.
- D. Regulatory Requirements: Comply with applicable provisions in ICC A117.1 for shower and dressing compartments designated as accessible.

2.2 HARDWARE AND ACCESSORIES

- A. Curtain Rod with Hooks: Manufacturer's standard, 1-inch- diameter, stainless steel curtain rod with matching hooks.
- B. Curtain: Flame-resistant, manufacturer's standard fabric that is stain resistant, self-sanitizing, antistatic, antimicrobial, and launderable to a temperature of not less than 90 deg F.
 - 1. Flame Resistance: Passes NFPA 701 tests when tested by a testing and inspecting agency acceptable to authorities having jurisdiction.
 - 2. Curtain Grommets: Two-piece, rolled-edge, rustproof, nickel-plated brass; spaced not more than 6 inches o.c.; machined into top hem.
 - 3. Width: Minimum 12 inches wider than opening.
 - 4. Length: Where curtain extends to a floor surface, size so that bottom hem clears finished floor by not more than 1 inch and not less than 1/2 inch above floor surface. Where curtains extend to a shower-receptor curb, size so that bottom hem hangs above curb line and clears curb line by not more than 1/2 inch.
 - 5. Color and Pattern: As indicated by manufacturer's designations.
- C. Soap Holder:
 - 1. Manufacturer's standard.
- D. Anchorages and Fasteners: Manufacturer's standard, exposed fasteners of stainless steel, chrome-plated steel, or solid brass, finished to match the items they are securing; with theft-resistant-type heads. Provide sex-type bolts for through-bolt applications. Use countersunk, flush-type bolt heads or otherwise make fasteners inconspicuous if exposed on opposite side of panel from hardware or accessory item. For concealed anchors, use stainless steel, hot-dip galvanized steel, or other rust-resistant, protective-coated steel compatible with related materials.

2.3 MATERIALS

- A. Aluminum Castings: ASTM B26/B26M.
- B. Aluminum Extrusions: ASTM B221.
- C. Stainless Steel Sheet: ASTM A240/A240M or ASTM A666, Type 304, stretcher-leveled standard of flatness.

- D. Stainless Steel Castings: ASTM A743/A743M.

2.4 FABRICATION

- A. Fabricate shower and dressing compartment components to sizes indicated.
- B. Overhead-Braced Compartments: Manufacturer's standard, corrosion-resistant supports, leveling method, and anchors at pilasters and walls to suit floor and wall conditions. Provide shoes at pilasters to conceal supports and leveling method.
- C. Floor-and-Ceiling-Anchored Compartments: Manufacturer's standard, corrosion-resistant anchoring assemblies at pilasters and walls, with leveling adjustment at tops and bottoms of pilasters. Provide shoes and sleeves (caps) at pilasters to conceal anchorage.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas and conditions, with Installer present, for compliance with requirements for fastening, support, alignment, operating clearances, and other conditions affecting performance of the Work.
 - 1. Confirm location and adequacy of blocking and supports required for installation.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF SOLID-PLASTIC SHOWER AND DRESSING COMPARTMENTS

- A. General: Comply with manufacturer's written installation instructions. Install compartments rigid, straight, level, and plumb. Secure compartments in position with manufacturer's recommended anchoring devices.
 - 1. Clearances for Dressing Compartments: Maximum 1/2 inch between pilasters and panels; 1 inch between panels and walls.
 - 2. Stirrup Brackets: Secure panels to walls and to pilasters with no fewer than three brackets attached at midpoint and near top and bottom of panel.
 - a. Locate wall brackets so holes for wall anchors occur in masonry or tile joints.
 - b. Align brackets at pilasters with brackets at walls.
 - 3. Full-Height (Continuous) Brackets: Secure panels to walls and to pilasters with full-height brackets.
 - a. Locate bracket fasteners so holes for wall anchors occur in masonry or tile joints.
 - b. Align brackets at pilasters with brackets at walls.
- B. Overhead-Braced Compartments: Secure pilasters to floor, and level, plumb, and tighten. Set pilasters with anchors penetrating not less than 1-3/4 inches into structural

floor unless otherwise indicated in manufacturer's written instructions. Secure continuous headrail to each pilaster with no fewer than two fasteners.

- C. Floor-and-Ceiling-Anchored Compartments: Secure pilasters to supporting construction, and level, plumb, and tighten.
- D. Curtains: Install curtains to specified length, and verify that they hang vertically without stress points or diagonal folds.
- E. Shower Receptors: Install manufacturer's prefabricated shower receptors with drain gasket compression fit to OD of waste pipe.

3.3 ADJUSTING AND CLEANING

- A. Curtain Adjustment: After hanging curtains, test and adjust each track or rod to produce unencumbered, smooth operation. Steam and dress down curtains as required to produce crease- and wrinkle-free installation. Remove and replace curtains that are stained or soiled or that have stress points or diagonal folds.
- B. Clean exposed surfaces of compartments after removing strippable, temporary protective covering. Comply with manufacturer's written instructions for stripping of temporary protective covering and cleaning. Replace damaged or defective items.

END OF SECTION 102116.19

SECTION 102800 - TOILET, BATH, AND LAUNDRY ACCESSORIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification Sections, apply to work of this section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Private-use bathroom accessories.
 - 2. Underlavatory guards.
 - 3. Custodial accessories.
 - 4. Hand-sanitizer dispensers.
- B. Related Requirements:
 - 1. Section 088300 "Mirrors" for frameless mirrors.
 - 2. Section 093013 "Ceramic Tiling" for ceramic toilet and bath accessories.

1.3 COORDINATION

- A. Coordinate accessory locations with other work to prevent interference with clearances required for access by people with disabilities, and for proper installation, adjustment, operation, cleaning, and servicing of accessories.
- B. Deliver inserts and anchoring devices set into concrete or masonry as required to prevent delaying the Work.

1.4 ACTION SUBMITTALS

- A. Product Data:
 - 1. Private-use bathroom accessories.
 - 2. Underlavatory guards.
 - 3. Custodial accessories.
 - 4. Hand-sanitizer dispensers.
- B. Product Data Submittals: For each product.
 - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
 - 2. Include anchoring and mounting requirements, including requirements for cutouts in other work and substrate preparation.
- C. Delegated Design Submittals: For grab bars and shower seats.
 - 1. Include structural design calculations indicating compliance with specified

structural-performance requirements.

1.5 INFORMATIONAL SUBMITTALS

- A. Sample Warranty: For manufacturer's special warranties.

1.6 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For accessories to include in maintenance manuals.

1.7 WARRANTY

- A. Manufacturer's Special Warranty for Mirrors: Manufacturer agrees to repair or replace mirrors that fail in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, visible silver spoilage defects.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Structural Performance: Design accessories and fasteners to comply with the following requirements:
 - 1. Grab Bars: Installed units are able to resist 250 lbf concentrated load applied in any direction and at any point.
 - 2. Shower Seats: Installed units are able to resist 250 lbf concentrated load applied in any direction and at any point.

2.2 PRIVATE-USE BATHROOM ACCESSORIES

- A. Source Limitations: Obtain each type of private-use bathroom accessory from single source from single manufacturer.

2.3 CUSTODIAL ACCESSORIES

- A. Source Limitations: Obtain custodial accessories from single source from single manufacturer.

2.4 MATERIALS

- A. Stainless Steel: ASTM A240/A240M or ASTM A666, Type 304, 0.031-inch- minimum nominal thickness unless otherwise indicated.
- B. Steel Sheet: ASTM A1008/A1008M, Designation CS (cold rolled, commercial steel), 0.036-inch- minimum nominal thickness.
- C. Galvanized-Steel Sheet: ASTM A653/A653M, with G60 hot-dip zinc coating.

- D. Galvanized-Steel Mounting Devices: ASTM A153/A153M, hot-dip galvanized after fabrication.
- E. Fasteners: Screws, bolts, and other devices of same material as accessory unit, unless otherwise recommended by manufacturer or specified in this Section, and tamper and theft resistant where exposed, and of stainless or galvanized steel where concealed.
- F. Mirrors: ASTM C1503, Mirror Glazing Quality, clear-glass mirrors, nominal 6.0 mm thick.

2.5 FABRICATION

- A. General: Fabricate units with tight seams and joints, and exposed edges rolled. Hang doors and access panels with full-length, continuous hinges. Equip units for concealed anchorage and with corrosion-resistant backing plates.
- B. Keys: Provide universal keys for internal access to accessories for servicing and resupplying. Provide minimum of six keys to Owner's representative.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install accessories in accordance with manufacturers' written instructions, using fasteners appropriate to substrate indicated and recommended by unit manufacturer. Install units level, plumb, and firmly anchored in locations and at heights indicated.
 - 1. Remove temporary labels and protective coatings.
- B. Grab Bars: Install to comply with specified structural-performance requirements.
- C. Shower Seats: Install to comply with specified structural-performance requirements.

3.2 ADJUSTING AND CLEANING

- A. Adjust accessories for unencumbered, smooth operation. Replace damaged or defective items.
- B. Clean and polish exposed surfaces in accordance with manufacturer's written instructions.

END OF SECTION 102800

SECTION 104416 - FIRE EXTINGUISHERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification Sections, apply to work of this section.

1.2 SUMMARY

- A. Section includes portable, hand-carried fire extinguishers and mounting brackets for fire extinguishers.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product. Include rating and classification, material descriptions, dimensions of individual components and profiles, and finishes for fire extinguisher and mounting brackets.
- B. Product Schedule: For fire extinguishers. Coordinate final fire-extinguisher schedule with fire-protection cabinet schedule to ensure proper fit and function.

1.4 INFORMATIONAL SUBMITTALS

- A. Warranty: Sample of special warranty.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For fire extinguishers to include in maintenance manuals.

1.6 COORDINATION

- A. Coordinate type and capacity of fire extinguishers with fire-protection cabinets to ensure fit and function.

1.7 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace fire extinguishers that fail in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Failure of hydrostatic test according to NFPA 10 when testing interval required by NFPA 10 is within the warranty period.
 - b. Faulty operation of valves or release levers.

2. Warranty Period: Six years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. NFPA Compliance: Fabricate and label fire extinguishers to comply with NFPA 10, "Portable Fire Extinguishers."
- B. Fire Extinguishers: Listed and labeled for type, rating, and classification by an independent testing agency acceptable to authorities having jurisdiction.

2.2 PORTABLE, HAND-CARRIED FIRE EXTINGUISHERS

- A. Fire Extinguishers: Type, size, and capacity for each mounting bracket indicated.
 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Amerex Corporation
 - b. Ansul
 - c. Babcock-Davis
 - d. Badger Fire Protection
 - e. Buckeye Fire Equipment Company
 - f. Guardian Fire Equipment, Inc
 - g. J. L. Industries, Inc.
 - h. Kidde
 - i. Larsen's Manufacturing Company
 - j. Potter Roemer LLC
 - k. Pyro-Chem
 2. Source Limitations: Obtain fire extinguishers, fire-protection cabinets, and accessories, from single source from single manufacturer.
 3. Valves: Manufacturer's standard.
 4. Handles and Levers: Stainless steel.
 5. Instruction Labels: Include pictorial marking system complying with NFPA 10, Appendix B, and bar coding for documenting fire-extinguisher location, inspections, maintenance, and recharging.
- B. Multipurpose Dry-Chemical Type in Aluminum: UL-rated 4-A:60-B:C, 10-lb nominal capacity, with monoammonium phosphate-based dry chemical in enameled-aluminum container.

2.3 MOUNTING BRACKETS

- A. Mounting Brackets: Manufacturer's standard steel, designed to secure fire extinguisher to wall or structure, of sizes required for types and capacities of fire extinguishers indicated, with plated or black baked-enamel finish.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Amerex Corporation
 - b. Ansul
 - c. Babcock-Davis
 - d. Badger Fire Protection
 - e. Buckeye Fire Equipment Company
 - f. Guardian Fire Equipment, Inc
 - g. J. L. Industries, Inc.
 - h. Kidde
 - i. Larsen's Manufacturing Company
 - j. Nystrom, Inc.
 - k. Pyro-Chem
 2. Source Limitations: Obtain mounting brackets and fire extinguishers from single source from single manufacturer.
- B. Identification: Lettering complying with authorities having jurisdiction for letter style, size, spacing, and location. Locate as indicated by Architect.
1. Identify bracket-mounted fire extinguishers with the words "FIRE EXTINGUISHER" in red letter decals applied to mounting surface.
 - a. Orientation: Vertical.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine fire extinguishers for proper charging and tagging.
 1. Remove and replace damaged, defective, or undercharged fire extinguishers.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. General: Install fire extinguishers and mounting brackets in locations indicated and in compliance with requirements of authorities having jurisdiction.
- B. Mounting Brackets: Fasten mounting brackets to surfaces, square and plumb, at locations indicated.
 1. Mounting Height: Top of fire extinguisher to be at 42 inches above finished floor.

END OF SECTION 104416

SECTION 105129 - PHENOLIC LOCKERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification Sections, apply to work of this section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Phenolic lockers.

1.3 ACTION SUBMITTALS

- A. Product Data:
 - 1. For each type of phenolic locker.
 - a. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
- B. Shop Drawings:
 - 1. Plans, elevations, sections, and attachment details.
 - 2. Locations and sizes of furring, blocking, and hanging strips, including concealed blocking and reinforcement specified in other Sections.
 - 3. Locations and sizes of cutouts and holes for items installed in lockers.
 - 4. Locker fillers, trim, base, sloping tops, and accessories.
 - 5. Locker identification system and numbering sequence.
- C. Samples for Initial Selection: Manufacturer's standard color sheets, showing full range of available colors for each type of phenolic locker. Include full range of available options for hardware and accessories involving material, finish, and/or color selection.

1.4 INFORMATIONAL SUBMITTALS

- A. Sample Warranties: For phenolic lockers.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For phenolic lockers including adjusting, repairing, and replacing locker doors and latching mechanisms.

1.6 MAINTENANCE MATERIAL SUBMITTALS

- A. Extra Stock Materials: Furnish extra materials to Owner that match products installed and that are packaged with protective covering for storage and identified with labels

describing contents.

1. Locker doors, complete with specified door hardware. Furnish no fewer than two doors of each type and color installed.
2. Units of the following locker hardware items equal to 10 percent of amount installed for each type and finish installed, but no fewer than five units:
 - a. Hinges.
 - b. Pulls.
 - c. Cylinder locks.
 - d. Blank number identification plates.
 - e. Hooks.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Do not deliver lockers until spaces to receive them are clean, dry, and ready for their installation.
- B. Deliver master and control keys to Owner by registered mail or overnight package service.

1.8 FIELD CONDITIONS

- A. Field Measurements: Verify actual dimensions of construction contiguous with lockers by field measurements, and coordinate before fabrication.

1.9 COORDINATION

- A. Coordinate sizes and locations of concealed wood support bases.
 1. Requirements are specified in Section 061000 "Rough Carpentry."
- B. Coordinate sizes and locations of framing, blocking, furring, reinforcements, and other related units of work specified in other Sections to ensure that lockers can be supported and installed as indicated.

1.10 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace components of lockers that fail in materials or workmanship within specified warranty period.
 1. Failures include, but are not limited to, the following:
 - a. Structural failures.
 - b. Faulty operation of locks or hardware.
 - c. Deterioration of finishes and materials beyond normal use.
 2. Warranty Period: Ten years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

- A. Obtain phenolic lockers and hardware and accessories from single source from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

- A. Surface-Burning Characteristics: Comply with ASTM E84 or UL 723; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
 - 1. Flame-Spread Index: 25 or less.
 - 2. Smoke-Developed Index: 450 or less.
- B. Accessibility Regulations: Comply with applicable provisions in ICC A117.1 for lockers designated as accessible.

2.3 HARDWARE

- A. Locking Device:
 - 1. Cylinder Lock: Built-in, flush cam locks with five-pin tumbler keyway, keyed separately and master keyed. Furnish two change keys for each lock and two master keys.
 - a. Key Type: Grooved, with minimum 2-by-2.68-inch key head for accessible lockers.
- B. Hinges:
 - 1. Manufacturer's standard.
 - 2. Butt Hinges: 2-3/4-inch, five-knuckle stainless steel hinges; back mounted, with not less than 120 degrees of opening.
 - a. Provide two hinges for doors 36 inches high and less.
 - b. Provide three hinges for doors more than 36 inches high.
 - 3. Continuous Hinges: Full height, back mounted; manufacturer's standard material and finish.
 - 4. Frameless Hinges (European Type): Fully concealed, with not less than 110 degrees of opening; manufacturer's standard material and finish.
 - a. Provide two hinges for doors 36 inches high and less.
 - b. Provide three hinges for doors more than 36 inches high.
- C. Handle:

Standard handle types for phenolic lockers vary by manufacturer. Most use wire pulls or recessed handles, but other options may be available. Retain "Wire Pulls" or "Recessed Handle" Subparagraph below or insert additional type(s). Verify availability with manufacturers.

- 1. Wire Pulls: Back mounted.

- a. Size: Manufacturer's standard.
 - b. Material and Finish: Manufacturer's standard.
- 2. Accessible Handle: Metal, fixed, graspable lever handle and rose trim; surface mounted.
 - a. Material and Finish: Manufacturer's standard.
- D. Hooks: Ball-pointed hooks. Attach hooks with at least two fasteners.
 - 1. Hook Configuration:
 - a. Manufacturer's standard.
 - 2. Material and Finish: Manufacturer's standard.

2.4 ACCESSORIES

- A. Number Identification:
 - 1. Manufacturer's standard.

2.5 MATERIALS

- A. Anchors: Material, type, size, and finish as required for each substrate for secure anchorage. Provide metal expansion sleeves or expansion bolts for post-installed anchors. Use nonferrous-metal or hot-dip galvanized anchors and inserts at inside face of exterior walls and at floors.

2.6 FABRICATION

- A. Fabricate each locker with shelves, an individual door and frame, an individual top, a bottom, and a back, and with common intermediate uprights separating compartments.
 - 1. Fabricate lockers to dimensions, profiles, and details indicated.
- B. Fabricate lockers square, rigid, without warp, and with finished faces flat and free of dents, scratches, and chips. Accurately factory machine components for attachments. Make joints tight and true.
- C. Accessible Lockers: Fabricate as follows:
 - 1. Locate bottom shelf no lower than 15 inches above the floor.
 - 2. Where hooks, coat rods, or additional shelves are provided, locate no higher than 48 inches above the floor.
- D. Venting: Fabricate lockers with space between doors and locker assembly of not less than 1/4 inch.
- E. Complete fabrication, including assembly, finishing, and hardware application, to maximum extent possible, before shipment to Project site. Disassemble components only as necessary for shipment and installation. Where necessary for fitting at site, provide ample allowance for scribing, trimming, and fitting.
 - 1. Use only manufacturer's nuts, bolts, screws, and other devices for assembly.

- F. Shop cut openings, to maximum extent possible, to receive hardware, electrical work, and similar items. Locate openings accurately and use templates or roughing-in diagrams to produce accurately sized and shaped openings. Sand edges of cutouts to remove splinters and burrs.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine walls and floors or support bases, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Verify that furring is attached to concrete and masonry walls that are to receive lockers.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install wood support base with 1/2-inch- thick, plywood top.
- B. Install lockers level, plumb, and true; shim as required, using concealed shims.
 - 1. Connect single rows of lockers together side-to-side at each locker. Use manufacturer's standard connecting bolts, through predrilled holes, with no exposed fasteners on face frames. Fit lockers accurately together to form flush, tight, hairline joints.
 - 2. Anchor locker runs at ends and at intervals recommended by manufacturer, but not more than 36 inches o.c., using manufacturer's standard concealed fasteners for material indicated.
 - a. Anchor single rows of lockers to walls near top and bottom of lockers.
- C. Install lockers without distortion so doors fit openings properly and are accurately aligned. Adjust hardware to center doors in openings, providing unencumbered operation. Complete installation of hardware and accessory items as indicated.
- D. Installation Tolerance: No more than 1/8 inch in 96-inch sag, bow, or other variation from a straight line. Shim as required with concealed shims.
- E. Scribe and cut corner and filler panels to fit adjoining work using fasteners concealed where practical. Repair damaged finish at cuts.
- F. Attach sloping-top units to lockers, with end panels covering exposed ends.
- G. Install number identification plates after lockers are in place.
 - 1. Attach number identification plate on each locker door, near top, centered, with at least two screws with finish matching the plate.

3.3 ADJUSTING

- A. Clean, lubricate, and adjust hardware. Adjust doors to operate easily without binding. Verify that integral locking devices operate properly.

3.4 PROTECTION

- A. Protect lockers from damage, abuse, dust, dirt, stain, or paint. Do not permit use during construction.
- B. Touch up marred finishes, or replace lockers that cannot be restored to factory-finished appearance. Use only materials and procedures recommended or furnished by locker manufacturer.

END OF SECTION 105129

SECTION 122113 - HORIZONTAL LOUVER BLINDS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification Sections, apply to work of this section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Horizontal louver blinds, polymer slats.
- B. Related Requirements:
 - 1. Section 061000 "Rough Carpentry" for wood blocking and grounds for mounting horizontal louver blinds and accessories.

1.3 ACTION SUBMITTALS

- A. Product Data:
 - 1. Horizontal louver blinds, polymer slats.
- B. Product Data Submittals: For each product.
 - 1. Construction details, material descriptions, dimensions of individual components and profiles, and finishes.
 - 2. Rated capacities, operating characteristics, and furnished accessories.
- C. Shop Drawings: For horizontal louver blinds.
 - 1. Fabrication and installation details.
- D. Samples for Initial Selection: Manufacturer's standard color sheets, showing full range of available colors for each type and color of horizontal louver blind.
 - 1. Include Samples of accessories involving color selection.

1.4 INFORMATIONAL SUBMITTALS

- A. Product Test Reports: For horizontal louver blinds with polymer slats that have been tested for compliance with NFPA 701, for tests performed by a qualified testing agency.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For horizontal louver blinds.

1.6 MAINTENANCE MATERIAL SUBMITTALS

- A. Extra Stock Material: Furnish extra materials, from the same production run, to Owner that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Horizontal Louver Blinds: Full-size units equal to 5 percent of quantity installed for each size, color, texture, pattern, and gloss indicated, but no fewer than two units. Include brackets.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Deliver horizontal louver blinds in factory packages, marked with manufacturer, product name, and location of installation, using same designations indicated on Drawings.

1.8 FIELD CONDITIONS

- A. Environmental Limitations: Do not install horizontal louver blinds until construction and wet-work and finish work in spaces, including painting, is complete and dry and ambient temperature and humidity conditions are maintained at levels indicated for Project when occupied for its intended use.
- B. Field Measurements: Where horizontal louver blinds are indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication and indicate measurements on Shop Drawings. Allow clearances for operating hardware of operable glazed units through entire operating range. Notify Architect of installation conditions that vary from Drawings. Coordinate fabrication schedule with construction progress to avoid delaying the Work.

1.9 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace components of motorized products that fail in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Faulty operation of motorized operating system components.
 - 2. Warranty Period: 5 year(s) from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

- A. Obtain horizontal louver blinds from single source from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

- A. Window Covering Safety Standard: Provide horizontal louver blinds that comply with WCMA A100.1.

2.3 FABRICATION OF HORIZONTAL LOUVER BLINDS

- A. Unit Sizes: Fabricate units in sizes to fill window and other openings as follows, measured at 74 deg F:
 - 1. Between (Inside) Jamb Installation: Width equal to jamb-to-jamb dimension of opening in which blind is installed less 1/4 inch per side or 1/2 inch total, plus or minus 1/8 inch. Length equal to head-to-sill dimension of opening in which blind is installed less 1/4 inch, plus or minus 1/8 inch.
- B. Concealed Components: Noncorrodible or corrosion-resistant-coated materials.
 - 1. Lift-and-Tilt Mechanisms: With permanently lubricated moving parts.
- C. Mounting Brackets: Designed for removal and reinstallation of blind without damaging blind and adjacent surfaces, for supporting blind components, and for bracket positions and blind mounting method indicated.
- D. Installation Fasteners: No fewer than two fasteners per bracket, fabricated from metal noncorrosive to brackets and adjoining construction; type designed for securing to supporting substrate; and supporting blinds and accessories under conditions of normal use.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances, operational clearances, and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF HORIZONTAL LOUVER BLINDS

- A. Install horizontal louver blinds level and plumb, aligned and centered on openings, and aligned with adjacent units in accordance with manufacturer's written instructions.
 - 1. Locate so exterior slat edges are not closer than 1 inch from interior faces of glass and not closer than 1/2 inch from interior faces of glazing frames through full operating ranges of blinds.
 - 2. Install mounting brackets to prevent deflection of headrails.
 - 3. Install with clearances that prevent interference with adjacent blinds, adjacent construction, and operating hardware of glazed openings, other window treatments, and similar building components and furnishings.

3.3 ADJUSTING

- A. Adjust horizontal louver blinds to operate free of binding or malfunction through full operating ranges.

3.4 CLEANING AND PROTECTION

- A. Clean horizontal louver blind surfaces after installation in accordance with manufacturer's written instructions.
- B. Provide final protection and maintain conditions in a manner acceptable to manufacturer and Installer that ensures that horizontal louver blinds are without damage or deterioration at time of Substantial Completion.
- C. Replace damaged horizontal louver blinds that cannot be repaired in a manner approved by Architect before time of Substantial Completion.

END OF SECTION 122113

SECTION 123213 - MANUFACTURED WOOD-VENEER-FACED CASEWORK

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification Sections, apply to work of this section.

1.2 SUMMARY

- A. Section Includes:

- 1. Wood-veneer-faced casework.
- 2. Hardware and accessories.

- B. Related Requirements:

- 1. Section 061000 "Rough Carpentry" for wood blocking for anchoring casework.
- 2. Section 092216 "Non-Structural Metal Framing" for reinforcements in metal-framed partitions for anchoring casework.
- 3. Section 096513 "Resilient Base and Accessories" for resilient base applied to wood-veneer-faced casework.

1.3 DEFINITIONS

- A. Definitions in the AWI/AWMAC/WI's "Architectural Woodwork Standards" apply to the Work of this Section.

1.4 COORDINATION

- A. Coordinate sizes and locations of framing, blocking, furring, reinforcements, and other related units of Work specified in other Sections to ensure that casework can be supported and installed as indicated.

1.5 ACTION SUBMITTALS

- A. Product Data:

- 1. Wood-veneer-faced casework.
- 2. Hardware and accessories.

- B. Shop Drawings: For wood-veneer-faced casework.

- 1. Include plans, elevations, sections, and attachments to other work including blocking and reinforcements required for installation.
- 2. Indicate types and sizes of casework.
- 3. Indicate manufacturer's catalog numbers for casework.
- 4. Show fabrication details, including types and locations of hardware.
- 5. Indicate locations of and clearances from adjacent walls, doors, windows, other

building components, and equipment.

- C. Samples: For casework and hardware finishes.
- D. Samples for Initial Selection: For casework and hardware finishes.

1.6 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For casework manufacturer and Installer.
- B. Sample Warranty: For special warranty.
- C. Field quality-control reports.

1.7 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish complete touchup kit for each casework finish provided. Include fillers, stains, finishes, and other materials necessary to perform permanent repairs to damaged casework finish.

1.8 QUALITY ASSURANCE

- A. Installer Qualifications: An authorized representative who is trained and approved by manufacturer.

1.9 DELIVERY, STORAGE, AND HANDLING

- A. Protect finished surfaces during handling and installation with protective covering of polyethylene film or other suitable material.

1.10 FIELD CONDITIONS

- A. Environmental Limitations: Do not deliver or install casework until building is enclosed, wet-work is complete, and HVAC system is operating and maintaining temperature and relative humidity at levels planned for building occupants during remainder of construction period. Maintain temperature and relative humidity during remainder of construction period in range recommended for Project location by the AWI/AWMAC/WI's "Architectural Woodwork Standards."
- B. Established Dimensions: Where casework is indicated to fit to other construction, establish dimensions for areas where casework is to fit. Provide allowance for trimming at site, and coordinate construction to ensure that actual dimensions correspond to established dimensions.
- C. Field Measurements: Where casework is indicated to fit to existing construction, verify dimensions of existing construction by field measurements before fabrication and indicate measurements on Shop Drawings. Provide fillers and scribes to allow for trimming and fitting.

- D. Locate concealed framing, blocking, and reinforcements that support casework by field measurements before enclosing them, and indicate measurements on Shop Drawings.

1.11 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace components of casework that fail in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Delamination of components or other failures of glue bond.
 - b. Warping of components.
 - c. Failure of operating hardware.
 - d. Deterioration of finishes.
 - 2. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR CASEWORK

- A. Quality Standard: Unless otherwise indicated, comply with the AWI/AWMAC/WI's "Architectural Woodwork Standards" for grades of casework indicated for construction, finishes, installation, and other requirements.
 - 1. Grade: Premium.

2.2 HARDWARE AND ACCESSORIES

- A. Hardware: Unless otherwise indicated, provide manufacturer's standard satin-finish, commercial-quality, heavy-duty hardware.
 - 1. Use threaded metal or plastic inserts with machine screws for fastening to particleboard except where hardware is through-bolted from back side.
- B. Butt Hinges: Stainless steel, semi-concealed, five-knuckle hinges complying with ANSI/BHMA A156.9, Grade 1, with antifriction bearings and rounded tips. Provide two hinges for doors less than 48 inches high and provide three hinges for doors more than 48 inches high.
- C. Wire Pulls: Solid stainless steel wire pulls, fastened from back with two screws.
 - 1. Provide two pulls for drawers more than 24 inches wide.
- D. Door Catches: Zinc-plated nylon-roller spring catch. Provide two catches on doors more than 48 inches high.
- E. Door and Drawer Bumpers: Self-adhering, clear silicone rubber.
 - 1. Doors: Provide one bumper at top and bottom of closing edge of each swinging door.
 - 2. Drawers: Provide one bumper on back side of drawer front at each corner.

- F. Drawer Slides: ANSI/BHMA A156.9.
 - 1. Manufacturer's standard.
- G. Adjustable Shelf Supports:
 - 1. Mortise-type, zinc-plated steel standards and shelf rests complying with ANSI/BHMA A156.9, Type B04071 and Type B04091.

2.3 MATERIALS

- A. Maximum Moisture Content for Lumber: 7 percent for hardwood and 12 percent for softwood.
- B. Hardwood Plywood: HPVA HP-1, particleboard core except where veneer core is indicated.
- C. Softwood Plywood: DOC PS 1.
- D. Particleboard: ANSI A208.1, Grade M-2.
- E. MDF: Medium-density fiberboard, ANSI A208.2, [Grade 130] <Insert grade>.
- F. Hardboard: ANSI A135.4, Class 1 tempered.
- G. PVC Edgebanding for Wood: Rigid PVC extrusions, through color with satin finish, 3.0 mm thick at doors and drawer fronts, 1.0 mm thick elsewhere.
- H. Thermally Fused Laminate (TFL) Panels: Particleboard or MDF finished with thermally fused, melamine-impregnated decorative paper and complying with requirements of ISO 4586.
 - 1. Edgebanding for Thermally Fused Laminate (TFL) Panels: PVC or polyester edgebanding matching thermally fused laminate panels.

2.4 FABRICATION

- A. Wood-Veneer-Faced Cabinet Construction: As required by referenced quality standard, but not less than the following:
 - 1. Bottoms of Cabinets and Tops of Wall Cabinets: 3/4-inch- thick, hardwood plywood.
 - 2. Ends of Cabinets: 3/4-inch- thick, hardwood plywood.
 - 3. Shelves: 3/4-inch- thick, veneer-core hardwood plywood or 1-inch- thick, particleboard-core hardwood plywood.
 - 4. Base Cabinet Top Frames: 3/4-by-2-inch solid wood with mortise and tenon or doweled connections, glued and pinned or screwed.
 - 5. Base Cabinet Stretchers: 3/4-by-4-1/2-inch plywood, particleboard, or MDF strips or solid-wood boards at front and back of cabinet, glued and pinned or screwed. May be provided as an option to base cabinet top frames.
 - 6. Base Cabinet Subtops: 3/4-inch- thick panel product, glued and pinned or screwed. May be provided as an option to base cabinet top frames.

7. Backs of Cabinets: 3/4-inch- thick, particleboard-core hardwood plywood where exposed, 1/4-inch- thick hardboard, dadoed into sides, bottoms, and tops where not exposed.
 8. Drawer Fronts: 3/4-inch- thick, particleboard-core hardwood plywood or solid hardwood.
 9. Drawer Sides and Backs: 1/2-inch- thick, solid-wood or veneer-core hardwood plywood, with glued dovetail or multiple-dowel joints.
 10. Drawer Bottoms: 1/4-inch- thick, veneer-core hardwood plywood, glued and dadoed into front, back, and sides of drawers. Use 1/2-inch- thick material for drawers more than 24 inches wide.
 11. Drawer Bodies: Steel drawer pans formed from 0.036-inch- thick metal, metallic phosphate treated, and finished with manufacturer's standard two-coat, baked-enamel finish consisting of prime coat and thermosetting topcoat with a minimum dry film thickness of 1 mil for topcoat and 2 mils for system.
 12. Cabinet Doors:
 - a. 48 Inches (1220 mm) or Less in Height: 3/4 inch thick, with particleboard or MDF cores, and hardwood face veneers and crossbands.
 - b. 48 Inches (1220 mm) or More in Height: 1-1/16 inches thick, with solid hardwood stiles and rails, honeycomb cores, and hardwood face veneers and crossbands.
- B. Filler Strips: Provide as needed to close spaces between casework and walls, ceilings, and equipment. Fabricate from same material and with same finish as casework.

2.5 FINISH

- A. Preparation: Sand lumber and plywood before assembling. Sand edges of doors and drawer fronts and molded shapes with profile-edge sander. Sand casework after assembling for uniform smoothness at least equivalent to that produced by 220-grit sanding and without machine marks, cross sanding, or other surface blemishes.
- B. Staining: Remove fibers and dust and apply wash-coat sealer and stain to exposed and semiexposed surfaces as required to provide uniform color and to match approved Samples.
- C. Finishing Closed-Grain Woods: Apply manufacturer's standard two-coat, baked, clear finish consisting of a thermosetting catalyzed sealer and a thermosetting catalyzed conversion varnish. Sand and wipe clean between applications of sealer and topcoat. Topcoat may be omitted on concealed surfaces.
- D. Finishing Open-Grain Woods: Apply manufacturer's standard three-coat, baked, clear finish consisting of a thermosetting catalyzed sealer and two coats of a thermosetting catalyzed conversion varnish. Sand and wipe clean between applications of sealer and topcoat and between topcoats. Topcoats may be omitted on concealed surfaces.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas, with Installer present, for compliance with requirements for installation tolerances, location of framing and reinforcements, and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Grade: Install casework to comply with same quality standard grade as item to be installed.
- B. Install casework level, plumb, and true in line; shim as required using concealed shims. Where casework abuts other finished work, apply filler strips and scribe for accurate fit, with fasteners concealed where practical.
- C. Base Cabinets: Set cabinets straight, level, and plumb. Adjust subtops within 1/16 inch of a single plane. Align similar adjoining doors and drawers to a tolerance of 1/16 inch. Bolt adjacent cabinets together with joints flush, tight, and uniform.
- D. Wall Cabinets: Hang cabinets straight, level, and plumb. Adjust fronts and bottoms within 1/16 inch of a single plane. Fasten cabinets to hanging strips, masonry, framing, wood blocking, or reinforcements in walls and partitions. Align similar adjoining doors to a tolerance of 1/16 inch.
- E. Fasten casework to adjacent units and to masonry, framing, wood blocking, or reinforcements in walls and partitions to comply with the AWI/AWMAC/WT's "Architectural Woodwork Standards."
- F. Install hardware uniformly and precisely. Set hinges snug and flat in mortises unless otherwise indicated. Adjust and align hardware so moving parts operate freely and contact points meet accurately. Allow for final adjustment after installation.
- G. Adjust operating hardware so doors and drawers operate smoothly without warp or bind. Lubricate operating hardware as recommended by manufacturer.

3.3 CLEANING

- A. Repair or remove and replace defective work as directed on completion of installation.
- B. Clean finished surfaces, touch up as required, and remove or refinish damaged or soiled areas to match original factory finish, as approved by A/E.

END OF SECTION 123213

SECTION 123553.13 - METAL LABORATORY CASEWORK

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification Sections, apply to work of this section.

1.2 SUMMARY

- A. Section Includes:

1. Metal laboratory casework.
2. Countertops.
3. Laboratory casework systems.
4. Electrical and communication service fittings.

- B. Related Requirements:

1. Section 061000 "Rough Carpentry" for wood blocking for anchoring laboratory casework.
2. Section 096513 "Resilient Base and Accessories" for resilient base applied to laboratory casework.

1.3 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.
- B. Keying Conference: Conduct conference at Project site. Incorporate keying conference decisions into final keying requirements.

1.4 COORDINATION

- A. Coordinate layout and installation of framing and reinforcements for support of laboratory casework.
- B. Coordinate installation of laboratory casework with installation of laboratory equipment.

1.5 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: For laboratory casework.
 1. Include plans, elevations, sections, and attachments to other work including blocking and reinforcements required for installation.
 2. Indicate types and sizes of casework.
 3. Indicate manufacturer's catalog numbers for casework.

4. Show fabrication details, including types and locations of hardware.
 5. Indicate locations and types of service fittings.
 6. Include details of support framing system.
 7. Include details of exposed conduits, if required, for service fittings.
 8. Indicate locations of and clearances from adjacent walls, doors, windows, other building components, and laboratory equipment.
 9. Include coordinated dimensions for laboratory equipment specified in other Sections.
- C. Keying Schedule: Include schematic keying diagram, and index each key set to unique designations that are coordinated with the Contract Documents.
- D. Samples: For casework finishes and materials requiring color selection.
- E. Samples for Initial Selection: For casework finishes and materials requiring color selection.

1.6 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For manufacturer.
- B. Product Test Reports:
1. Casework: Based on evaluation of comprehensive tests performed by a qualified testing agency, indicating compliance of laboratory casework with requirements of specified product standard.
 2. Countertop Surface Material: Based on evaluation of comprehensive tests performed by a qualified testing agency, indicating compliance of laboratory countertop surface material with requirements specified for chemical and physical resistance.

1.7 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish complete touchup kit for each type and color of casework finish provided. Include fillers, primers, paints, and other materials necessary to perform permanent repairs to damaged laboratory casework finish.

1.8 QUALITY ASSURANCE

- A. Manufacturer Qualifications: A qualified manufacturer that produces casework of types indicated for this Project that has been tested for compliance with SEFA 8 M.

1.9 DELIVERY, STORAGE, AND HANDLING

- A. Protect finished surfaces during handling and installation with protective covering of polyethylene film or other suitable material.

1.10 FIELD CONDITIONS

- A. Environmental Limitations: Do not deliver or install laboratory casework until building is enclosed, utility roughing-in and wet-work are complete, and HVAC system is operating and maintaining temperature and relative humidity at levels planned for building occupants during the remainder of the construction period.
- B. Field Measurements: Where laboratory casework is indicated to fit to existing construction, verify dimensions of existing construction by field measurements before fabrication and indicate measurements on Shop Drawings. Provide fillers and scribes to allow for trimming and fitting.
- C. Locate concealed framing, blocking, and reinforcements that support casework by field measurements before enclosing them, and indicate measurements on Shop Drawings.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

- A. Obtain laboratory casework from single source from single manufacturer unless otherwise indicated.
- B. Product Designations: Drawings indicate sizes and configurations of laboratory casework by referencing designated manufacturer's catalog numbers. Other manufacturers' laboratory casework of similar sizes and similar door and drawer configurations and complying with Specifications may be considered. See Section 016000 "Product Requirements."

2.2 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design laboratory casework installation.
 - 1. Component Importance Factor: 1.5.

2.3 CASEWORK, GENERAL

- A. Casework Product Standard: Comply with SEFA 8 M, "Laboratory Grade Metal Casework."
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.4 CABINET HARDWARE

- A. General: Provide laboratory casework manufacturer's standard, commercial-quality, heavy-duty hardware complying with requirements indicated for each type.

- B. Hinges: Stainless steel, five-knuckle hinges complying with BHMA A156.9, Grade 1, with antifriction bearings and rounded tips. Provide two for doors 48 inches high or less and three for doors more than 48 inches high.
- C. Hinged-Door and Drawer Pulls: Solid-aluminum, stainless steel, or chrome-plated-brass back-mounted pulls. Provide two pulls for drawers more than 24 inches wide.
 - 1. Design: As selected from manufacturer's full range.
 - 2. Overall Size: As selected from manufacturer's full range.
- D. Door Catches: Nylon-roller spring catches. Provide two catches on doors more than 48 inches high.
- E. Drawer Slides: ANSI/BHMA A156.9.
 - 1. Manufacturer's standard.
 - 2. Heavy Duty (Grade 1HD-100): Side mount.
 - 3. General-purpose drawers; provide 100 lb load capacity.
 - 4. File drawers; provide 150 lb load capacity.
- F. Label Holders: Stainless steel, aluminum, or chrome plated; sized to receive standard label cards approximately 1 by 2 inches, attached with screws or rivets. Provide on drawers.
- G. Locks: Cam or half-mortise type, brass with chrome-plated finish; complying with BHMA A156.11, Type E07281, Type E07111, or Type E07021.
 - 1. Tumbler: Disc.
 - 2. Keying: Key locks as directed.
 - 3. Key Quantity: Minimum of two keys per lock.

2.5 COUNTERTOPS

- A. General: Provide laboratory countertops with integral sink as indicated on Drawings.

2.6 METAL CABINET FABRICATION

- A. General: Assemble and finish units at point of manufacture. Use precision dies for interchangeability of like-size drawers, doors, and similar parts. Perform assembly on precision jigs to provide units that are square. Reinforce units with angles, gussets, and channels. Except where otherwise specified, integrally frame and weld cabinet bodies to form dirt- and vermin-resistant enclosures. Where applicable, reinforce base cabinets for sink support. Maintain uniform clearance around door and drawer fronts of 1/16 to 3/32 inch.
- B. Flush Doors: Outer and inner pans that nest into box formation, with full-height channel reinforcements at center of door. Fill doors with noncombustible, sound-deadening material.
- C. Hinged Doors: Mortise for hinges and reinforce with angles welded inside inner pans at hinge edge.

- D. Drawers: Fronts made from outer and inner pans that nest into box formation, without raw metal edges at top. Sides, back, and bottom fabricated in one piece with rolled or formed top of sides for stiffening and comfortable grasp for drawer removal. Provide drawers with rubber bumpers, polymer roller slides, and positive stops to prevent metal-to-metal contact or accidental removal.
- E. Adjustable Shelves: Front, back, and ends formed down, with edges returned horizontally at front and back to form reinforcing channels.
- F. Toe Space: Fully enclosed, 4 inches high by 3 inches deep, with no open gaps or pockets.
- G. Tables: Welded tubing legs, not less than 2 inches square with channel stretchers as needed to comply with product standard. Weld or bolt stretchers to legs and cross-stretchers, and bolt legs to table aprons. Provide leveling device welded to bottom of each leg.
 - 1. Leg Shoes: Satin-finished, stainless steel, open-bottom, slip-on type.
- H. Utilities: Provide space, cutouts, and holes for pipes, conduits, and fittings in cabinet bodies to accommodate utility services and their support-strut assemblies.
 - 1. Provide base cabinets with removable backs for access to utility space.
- I. Filler and Closure Panels: Provide where indicated and as needed to close spaces between casework and walls, ceilings, and equipment. Fabricate from same material and with same finish as casework and with hemmed or flanged edges unless otherwise indicated.
 - 1. Provide closure panels at ends of utility spaces where utility space would otherwise be exposed.

2.7 LABORATORY CASEWORK SYSTEMS

- A. Provide casework manufacturer's standard integrated system that includes support framing, suspended modular cabinets, filler and closure panels, undercabinet task-lighting fixtures, countertops, and fittings needed to assemble system. System includes hardware and fasteners for securing support framing to permanent construction.
 - 1. Cabinets can be removed and reinstalled without use of special tools for relocation within system.
 - 2. Base cabinets can be removed without providing temporary support for, or removing, countertops.
 - 3. Sinks are supported independent of base cabinets.
 - 4. Support framing has provision for fastening pipe supports at utility space in not more than 1-inch increments.
 - 5. System includes filler and closure panels to close spaces between support framing, cabinets, shelves, countertops, floors, and walls unless otherwise indicated. Fabricate panels from same material and with same finish as metal cabinets and with hemmed or flanged edges.
- B. Undercabinet Task-Light Luminaires:

1. Lamp Type: LED with switch and heavy-duty cord and plug.
2. Finish: Baked enamel.
3. Diffusers: Virgin acrylic with high resistance to yellowing and other changes from aging, heat, and UV radiation.

C. Countertops: Provide in modular lengths indicated, without seams.

2.8 METAL CABINET FINISH

- A. General: Prepare, treat, and finish welded assemblies after assembling. Prepare, treat, and finish components that are to be assembled with mechanical fasteners before assembling. Prepare, treat, and finish concealed surfaces same as exposed surfaces.
- B. Preparation: After assembly, clean surfaces of mill scale, rust, oil, and other contaminants. After cleaning, apply a conversion coating suited to organic coating to be applied over it.
- C. Chemical-Resistant Finish: Immediately after cleaning and pretreating, apply laboratory casework manufacturer's standard two-coat, chemical-resistant, baked-on finish consisting of prime coat and thermosetting topcoat. Comply with coating manufacturer's written instructions for applying and baking to achieve a minimum dry film thickness of 2 mils.
 1. Chemical and Physical Resistance of Finish System: Finish complies with acceptance levels of cabinet surface finish tests in SEFA 8 M. Acceptance level for chemical spot test is to be no more than for Level 3 conditions.
 2. Colors for Metal Laboratory Casework Finish: As selected by A/E from manufacturer's full range.

2.9 COUNTERTOP FABRICATION

- A. Countertops, General: Provide units with smooth surfaces in uniform plane, free of defects. Make exposed edges and corners straight and uniformly beveled. Provide front and end overhang of 1 inch.
- B. Sinks, General: Provide sizes indicated or laboratory casework manufacturer's closest standard size of equal or greater volume, as approved by Architect.
 1. Outlets: Provide with strainers and tailpieces, NPS 1-1/2, unless otherwise indicated.
 2. Overflows: For each sink except cup sinks, provide overflow of standard beehive or open-top design with separate strainer. Height 2 inches less than sink depth. Provide in same material as strainer.
- C. Epoxy:
 1. Countertops: Fabricate with factory cutouts for sinks, holes for service fittings and accessories, and butt joints assembled with epoxy adhesive and concealed metal splines.
 - a. Flat Configuration: 3/4 inch thick with continuous drip groove on underside

1/2 inch from overhang edge.

- 1) Edges and Corners: Rounded.
- 2) Backsplash: Integral coved or Applied.

b. Construction: Uniform throughout full thickness.

2. Tabletops:

a. Flat Configuration: 3/4 inch thick with continuous drip groove on underside at perimeter.

- 1) Edges and Corners: Rounded.

b. Tabletop Construction: Uniform throughout full thickness.

3. Sinks: Molded in one piece with smooth surfaces, coved corners, and bottom sloped to outlet; 1/2-inch minimum thickness.

- a. Provide with polypropylene strainers and tailpieces.
- b. Provide integral sinks in epoxy countertops, bonded to countertops with invisible joint line.
- c. Provide sinks for underside installation with manufacturer's recommended adjustable support system for table- and cabinet-type installations.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas, with Installer present, for compliance with requirements for installation tolerances, location of reinforcements, and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF CABINETS

- A. Comply with installation requirements in SEFA 2. Install level, plumb, and true in line; shim as required using concealed shims. Where laboratory casework abuts other finished work, apply filler strips and scribe for accurate fit, with fasteners concealed where practical. Do not exceed the following tolerances:
 1. Variation of Tops of Base Cabinets from Level: 1/16 inch in 10 feet.
 2. Variation of Bottoms of Upper Cabinets from Level: 1/8 inch in 10 feet.
 3. Variation of Faces of Casework from a True Plane: 1/8 inch in 10 feet.
 4. Variation of Adjacent Surfaces from a True Plane (Lippage): 1/32 inch.
 5. Variation in Alignment of Adjacent Door and Drawer Edges: 1/16 inch.
- B. Utility-Space Framing: Secure to floor with two fasteners at each frame. Fasten to partition framing, wood blocking, or metal reinforcements in partitions and to base cabinets.

- C. Base Cabinets: Fasten cabinets to utility-space framing, partition framing, wood blocking, or reinforcements in partitions, with fasteners spaced not more than 16 inches o.c. Bolt adjacent cabinets together with joints flush, tight, and uniform.
 - 1. Where base cabinets are installed away from walls, fasten to floor at toe space at not more than 24 inches o.c. and at sides of cabinets with not less than two fasteners per side.
- D. Wall Cabinets: Fasten to hanging strips, masonry, partition framing, blocking, or reinforcements in partitions. Fasten each cabinet through back, near top, at not less than 16 inches o.c.
- E. Install hardware uniformly and precisely.
- F. Adjust operating hardware so doors and drawers align and operate smoothly without warp or bind and contact points meet accurately. Lubricate operating hardware as recommended by manufacturer.

3.3 INSTALLATION OF COUNTERTOPS

- A. Comply with installation requirements in SEFA 2. Abut top and edge surfaces true in plane with flush hairline joints and with internal supports placed to prevent deflection. Locate joints where indicated on Shop Drawings.
- B. Field Jointing: Where possible, make in same manner as shop-made joints, using dowels, splines, fasteners, adhesives, and sealants recommended by manufacturer. Shop prepare edges for field-made joints.
 - 1. Plastic-Laminate Countertops: Secure field-made joints using concealed clamping devices located within 6 inches of front and back edges and at intervals not exceeding 24 inches. Tighten in accordance with manufacturer's written instructions to exert a uniform heavy pressure at joints.
- C. Fastening:
 - 1. Secure countertops, except for epoxy countertops, to cabinets with Z-type fasteners or equivalent, using two or more fasteners at each cabinet front, end, and back.
 - 2. Secure epoxy countertops to cabinets with epoxy cement, applied at each corner and along perimeter edges at not more than 48 inches o.c.
 - 3. Where necessary to penetrate countertops with fasteners, countersink heads approximately 1/8 inch and plug hole flush with material equal to countertop in chemical resistance, hardness, and appearance.
- D. Provide holes and cutouts required for service fittings.
- E. Provide scribe moldings for closures at junctures of countertop, curb, and splash with walls as recommended by manufacturer for materials involved. Match materials and finish to adjacent laboratory casework. Use chemical-resistant, permanently elastic sealing compound where recommended by manufacturer.
- F. Dress joints smooth, remove surface scratches, and clean entire surface.

3.4 INSTALLATION OF SINKS

- A. Comply with installation requirements in SEFA 2.

3.5 INSTALLATION OF SERVICE FITTINGS

- A. Comply with requirements in other Sections for installing water and laboratory gas service fittings and electrical devices.
- B. Install fittings in accordance with Shop Drawings, installation requirements in SEFA 2, and manufacturer's written instructions. Set bases and flanges of sink- and countertop-mounted fittings in sealant recommended by manufacturer of sink or countertop material. Securely anchor fittings to laboratory casework unless otherwise indicated.

3.6 CLEANING AND PROTECTING

- A. Clean finished surfaces, touch up as required, and remove or refinish damaged or soiled areas to match original factory finish, as approved by Architect.
- B. Protect countertop surfaces during construction with 6-mil plastic or other suitable water-resistant covering. Tape to underside of countertop at a minimum of 48 inches o.c.

END OF SECTION 123553.13

SECTION 123661.16 - SOLID SURFACING COUNTERTOPS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification Sections, apply to work of this section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Solid surface material countertops.
 - 2. Solid surface material backsplashes.
 - 3. Solid surface material end splashes.

1.3 ACTION SUBMITTALS

- A. Product Data: For countertop materials.
- B. Shop Drawings: For countertops. Show materials, finishes, edge and backsplash profiles, methods of joining, and cutouts for plumbing fixtures.
 - 1. Show locations and details of joints.
- C. Samples for Initial Selection: For each type of material exposed to view.

1.4 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For solid surface material countertops to include in maintenance manuals. Include Product Data for care products used or recommended by Installer and names, addresses, and telephone numbers of local sources for products.

1.5 QUALITY ASSURANCE

- A. Fabricator Qualifications: Shop that employs skilled workers who custom-fabricate countertops similar to that required for this Project, and whose products have a record of successful in-service performance.
- B. Installer Qualifications: Fabricator of countertops.

1.6 FIELD CONDITIONS

- A. Field Measurements: Verify dimensions of countertops by field measurements after base cabinets are installed but before countertop fabrication is complete.

1.7 COORDINATION

- A. Coordinate locations of utilities that will penetrate countertops or backsplashes.

PART 2 - PRODUCTS

2.1 FABRICATION

- A. Fabricate countertops according to solid surface material manufacturer's written instructions and to the AWI/AWMAC/WI's "Architectural Woodwork Standards."
 - 1. Grade: Premium.
 - 2. Front: Straight, slightly eased at top.
 - 3. Backsplash: Straight, slightly eased at corner.
 - 4. End Splash: Matching backsplash.
- B. Countertops:
 - 1. 3/4-inch-thick, solid surface material with front edge built up with same material.
- C. Backsplashes: 3/4-inch-thick, solid surface material.
- D. Fabricate tops with shop-applied edges unless otherwise indicated. Comply with solid surface material manufacturer's written instructions for adhesives, sealers, fabrication, and finishing.
- E. Joints:
 - 1. Fabricate countertops without joints.
- F. Cutouts and Holes:
 - 1. Counter-Mounted Plumbing Fixtures: Prepare countertops in shop for field cutting openings for counter-mounted fixtures. Mark tops for cutouts and drill holes at corners of cutout locations. Make corner holes of largest radius practical.
 - 2. Fittings: Drill countertops in shop for plumbing fittings, undercounter soap dispensers, and similar items.

2.2 INSTALLATION MATERIALS

- A. Adhesive: Product recommended by solid surface material manufacturer.
- B. Sealant for Countertops: Comply with applicable requirements in Section 079200 "Joint Sealants."

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates to receive solid surface material countertops and conditions under which countertops will be installed, with Installer present, for compliance with

requirements for installation tolerances and other conditions affecting performance of countertops.

- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install countertops level to a tolerance of 1/8 inch in 8 feet, 1/4 inch maximum. Do not exceed 1/64-inch difference between planes of adjacent units.
- B. Fasten countertops by screwing through corner blocks of base units into underside of countertop. Predrill holes for screws as recommended by manufacturer. Align adjacent surfaces and, using adhesive in color to match countertop, form seams to comply with manufacturer's written instructions. Carefully dress joints smooth, remove surface scratches, and clean entire surface.
- C. Install backsplashes and end splashes by adhering to wall and countertops with adhesive. Mask areas of countertops and splashes adjacent to joints to prevent adhesive smears.
- D. Install aprons to backing and countertops with adhesive. Mask areas of countertops and splashes adjacent to joints to prevent adhesive smears. Fasten by screwing through backing. Predrill holes for screws as recommended by manufacturer.
- E. Complete cutouts not finished in shop. Mask areas of countertops adjacent to cutouts to prevent damage while cutting. Make cutouts to accurately fit items to be installed, and at right angles to finished surfaces unless beveling is required for clearance. Ease edges slightly to prevent snipping.
- F. Apply sealant to gaps at walls; comply with Section 079200 "Joint Sealants."

END OF SECTION 123661.16

SECTION 133419 - METAL BUILDING SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes a single-story, single-span, rigid-frame-type, open pre-engineered metal building of the nominal length, width, eave height, and roof pitch indicated.
 - 1. Roof system consists of the manufacturer's standard standing-seam uninsulated roof.
 - 2. Manufacturer's standard building components and accessories may be used, provided components, accessories, and complete structure conform to design indicated and specified requirements.
- B. Related Sections: The following sections contain requirements that relate to this section:
 - 1. Concrete slab and foundations and installation of anchor rods are specified in Division 3 Section "Concrete Work."

1.3 SYSTEM PERFORMANCE REQUIREMENTS

- A. General: Engineer, design, fabricate and erect the pre-engineered metal building system to withstand loads from winds, seismic, gravity, structural movement including movement thermally induced, and to resist in-service use conditions that the building will experience, including exposure to the weather, without failure.
 - 1. Design each member to withstand stresses resulting from combinations of loads that produce the maximum allowable stresses in that member as prescribed in MBMA's "Design Practices Manual."
 - 2. Limit total load drift to H/240 or 1" maximum, whichever is less.
 - 3. Limit deflection of framing members to L/320 or 1" maximum, whichever is less.
- B. Design Loads: Basic design loads, as well as auxiliary and collateral loads, are indicated on the structural drawings.
 - 1. Basic design loads include live load, wind load, and seismic load, in addition to the dead load.
 - 2. Collateral loads include additional dead and live loads over and above the weight of the metal building system such as sprinkler systems and roof-mounted mechanical systems.
- C. Structural Framing and Roof Panels: Design primary and secondary structural members and exterior covering materials for applicable loads and combinations of loads in

accordance with the Metal Building Manufacturers Association's (MBMA) "Design Practices Manual."

1. Structural Steel: Comply with the American Institute of Steel Construction's (AISC) "Specifications for the Design, Fabrication and Erection of Structural Steel for Buildings" for design requirements and allowable stresses.
2. Light Gage Steel: Comply with the American Iron and Steel Institute's (AISI) "Specification for the Design of Cold Formed Steel Structural Members" and "Design of Light Gage Steel Diaphragms" for design requirements and allowable stresses.
3. Welded Connections: Comply with the American Welding Society's (AWS) "Standard Code for Arc and Gas Welding in Building Construction" for welding procedures.

1.4 SUBMITTALS

- A. General: Submit the following in accordance with Conditions of the Contract and Division 1 Specification Sections.
- B. Product data consisting of metal building system manufacturer's product information for building components and accessories.
- C. Shop drawings for metal building structural framing system, roofing and other metal building system components and accessories that are not fully detailed or dimensioned in manufacturer's product data.
 1. Structural Framing: Furnish complete erection drawings prepared by or under the supervision of a professional engineer legally authorized to practice in the jurisdiction where the Project is located. Include details showing fabrication and assembly of the metal building system. Show anchor rod settings and sidewall, endwall, and roof framing. Include transverse cross-sections.
 2. Roofing Panels: Provide layouts of panels on roofs, details of edge conditions, joints, corners, custom profiles, supports, anchorages, trim, flashings, closures, and special details. Include transverse cross-sections.
 3. Building Accessory Components: Provide details of metal building accessory components to clearly indicate methods of installation including the following:
 - a. Sheet Metal Accessories: Provide layouts at 1/4 inch per foot (1:50) scale. Provide details of ventilators, louvers, gutters, downspouts, and other sheet metal accessories at not less than 1-1/2 inch per foot (1:10) scale showing profiles, methods of joining, and anchorages.
- D. Samples for initial selection purposes in form of manufacturer's color charts or chips showing full range of colors, textures, and patterns available for metal roofing and siding panels with factory-applied finishes.
- E. Samples for verification purposes of roofing and siding panels. Provide sample panels 12 inch (300 mm) long by actual panel width, in the profile, style, color, and texture indicated. Include clips, battens, fasteners, closures, and other panel accessories.

- F. Installer certificates signed by metal building manufacturer written certification certifying that the installer complies with requirements included under the "Quality Assurance" Article.
- G. Professional engineer's certificate prepared and signed by a Professional Engineer, legally authorized to practice in the jurisdiction where Project is located, verifying that the structural framing and covering panels meet indicated loading requirements and codes of authorities having jurisdiction.

1.5 QUALITY ASSURANCE

- A. **Installer Qualifications:** Engage an experienced Installer to erect the pre-engineered metal building who has specialized in the erection and installation of types of metal buildings systems similar to that required for this project and who is certified in writing by the metal building system manufacturer as qualified for erection of the manufacturer's products.
- B. **Manufacturer's Qualifications:** Provide pre-engineered metal buildings manufactured by a firm experienced in manufacturing metal buildings systems that are similar to those indicated for this project and have a record of successful in-service performance.
- C. **Single-Source Responsibility:** Obtain the metal building system components, including structural framing, wall and roof covering, and accessory components, from one source from a single manufacturer.
- D. **Design Criteria:** The drawings indicate sizes, profiles, and dimensional requirements of the pre-engineered metal building system. Metal building systems having equal performance characteristics with deviations from indicated dimensions and profiles may be considered, provided deviations do not change the design concept or intended performance. The burden of proof for equality is on the proposer.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver prefabricated components, sheets, panels, and other manufactured items so they will not be damaged or deformed. Package wall and roof panels for protection against transportation damage.
- B. **Handling:** Exercise care in unloading, storing, and erecting wall and roof covering panels to prevent bending, warping, twisting, and surface damage.
- C. Stack materials on platforms or pallets, covered with tarpaulins or other suitable weathertight ventilated covering. Store metal wall and roof panels so that water accumulations will drain freely. Do not store panels in contact with other materials that might cause staining, denting or other surface damage.

1.7 WARRANTY

- A. **Roofing Panel Finish Warranty:** Furnish the roofing panel manufacturer's written warranty, covering failure of the factory-applied exterior finish on metal roof panels within the

warranty period. This warranty shall be in addition to and not a limitation of other rights the Owner may have against the Contractor under the Contract Documents.

1. Warranty period for factory-applied exterior finishes on roof panels is 20 years after the date of Substantial Completion.

1.8 EXTRA MATERIALS

- A. Maintenance Stock: Furnish at least 5 percent excess over required amount of nuts, bolts, screws, washers, and other required fasteners for each metal building. Pack in cartons labeled to identify the contents and store on the site where directed. Also provide five (5) standard roof panels and five (5) standard wall panels.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturer: Subject to compliance with specified requirements, provide metal building systems provided by one of the following:
 1. A & S Building Systems, Inc.
 2. Butler Manufacturing Co.
 3. Ceco Buildings Division.
 4. Star Buildings Division, H. H. Robertson Co.
 5. Varco-Pruden Buildings.
 6. Western Steel Buildings

2.2 MATERIALS

- A. Hot-Rolled Structural Steel Shapes: Comply with ASTM A 36 (ASTM A 36M) or ASTM A 529 (ASTM A 529M).
- B. Steel Tubing or Pipe: Comply with ASTM A 500 Grade B, ASTM A 501, or ASTM A 53.
- C. Steel Members Fabricated from Plate or Bar Stock: Provide 42,000 psi (290 MPa) minimum yield strength. Comply with ASTM A 529 (ASTM A 529M), ASTM A 570 (ASTM A 570M), or ASTM A 572 (ASTM A 572M).
- D. Steel Members Fabricated by Cold Forming: Comply with ASTM A 607 Grade 50.
- E. Cold-Rolled Carbon Steel Sheet: Comply with requirements of ASTM A 366 (ASTM A 366M) or ASTM A 568 (ASTM A 568M).
- F. Hot-Rolled Carbon Steel Sheet: Comply with requirements of ASTM A 568 (ASTM A 568M) or ASTM A 569.
- G. Structural Quality Zinc-Coated (Galvanized) Steel Sheet: Comply with ASTM A 446 with G90 (ASTM A 446M with Z275) coating complying with ASTM A 525 (ASTM A 525M). Grade to suit manufacturer's standards.

- H. Aluminum-Coated Steel Sheets: Comply with ASTM A 463 with T1-40 coating.
- I. Aluminum Sheets: Comply with ASTM B 209 (ASTM B 209M) for Alclad alloy 3003 or 3004 with temper as required to suit forming operations.
- J. Bolts for Structural Framing: Comply with ASTM A 307 or ASTM A 325 (ASTM A 325M) as necessary for design loads and connection details.
- K. Anchor rods: Comply with ASTM F1554. Size and grading per final design requirements.
- L. Thermal Insulation: Glass fiber blanket insulation, complying with ASTM C 991, of 0.5 lb per cu. ft. (8 kg/cu. m) density, thickness as indicated, with UL flame spread classification of 25 or less, and 2 inch (50 mm) wide continuous vapor-tight edge tabs.
 - 1. Vapor Barrier: Vinyl-reinforced polyester.
 - 2. Retainer Strips: 26 gage (0.55 mm) formed galvanized steel retainer clips colored to match the insulation facing.
- M. Paint and Coating Materials: Comply with performance requirements of the federal specifications indicated. Unless specifically indicated otherwise, compliance with compositional requirements of federal specifications indicated is not required.
 - 1. Shop Primer for Ferrous Metal: Fast-curing, lead-free, universal primer, selected by the manufacturer for resistance to normal atmospheric corrosion, compatibility with finish paint systems, and capability to provide a sound foundation for field-applied topcoats despite prolonged exposure. Comply with FS TT-P-645.
 - 2. Shop Primer for Galvanized Metal Surfaces: Zinc dust-zinc oxide primer selected by the manufacturer for compatibility with substrate. Comply with FS TT-P-641.

2.3 STRUCTURAL FRAMING

- A. Rigid Frames: Fabricate from hot-rolled structural steel shapes, or provide factory-welded, shop-painted, built-up "I-beam"-shape or open-web-type frames consisting of tapered or parallel flange beams and tapered columns. Furnish frames with attachment plates, bearing plates, and splice members. Factory drill for field-bolted assembly.
 - 1. Provide length of span and spacing of frames indicated. Slight variations in length of span and frame spacing may be acceptable if necessary to meet manufacturer's standard and if approved by the Engineer in advance.
 - 2. Provide rigid frames at endwalls where indicated.
- B. Primary Endwall Framing: Provide the following primary endwall framing members fabricated for field-bolted assembly: (Note that no endwalls will extend to the foundation).
 - 1. Endwall Beams: Manufacturer's standard shop-painted "C"-shape roll-formed sections fabricated from 16 gage (1.5 mm) steel.
- C. Secondary Framing: Provide the following secondary framing members:

1. Roof Purlins, Sidewall and Endwall Girts: "C"-or "Z"-shaped sections fabricated from 16 gage (1.5 mm) shop-painted roll-formed steel. Purlin spacers shall be fabricated from 14 gage (2.0 mm) cold-formed galvanized steel sections.
 2. Eave Struts: Unequal flange "C"-shaped sections formed to provide adequate backup for both wall and roof panels. Fabricate from 16 gage (1.5 mm) shop-painted roll-formed steel.
 3. Flange and Sag Bracing: 1-5/8 x 1-5/8 inch (41 x 41 mm) angles fabricated from 16 gage (1.5 mm) shop-painted roll-formed steel.
- D. Bolts: Provide zinc-plated or cadmium-plated bolts when structural framing components are in direct contact with roofing and siding panels or exposed to exterior conditions.
- E. Shop Painting: Clean surfaces to be primed of loose mill scale, rust, dirt, oil, grease, and other matter precluding paint bond. Follow procedures of SSPC-SP3 for power-tool cleaning, SSPC-SP7 for brush-off blast cleaning, and SSPC-SP1 for solvent cleaning.
1. Prime structural steel primary and secondary framing members with the manufacturer's standard rust-inhibitive primer.
 2. Prime galvanized members, after phosphoric acid pretreatment, with manufacturer's standard zinc dust-zinc oxide primer. Galvanize all structural members exposed to exterior weather conditions and then prime paint.

2.4 ROOFING PANELS

- A. Face Sheets: Fabricate roof panel face sheets to the profile or configuration indicated from 26 gage (0.55 mm), structural quality, Grade C, zinc-coated steel sheets.
- B. Standing Seam Roof Panels: Manufacturer's standard factory-formed standing-seam roof panel system designed for mechanical attachment of panels to roof purlins using a concealed clip. Form panels of 26 gage (0.5 mm), Grade C, zinc-coated steel sheets.
1. Clips: Provide 16 gage (1.5 mm) panel clips.
 2. Cleats: Factory-calked, mechanically seamed cleats formed from 24 gage (0.70 mm), Grade C, zinc-coated steel sheets.
- C. Fasteners: Self-tapping screws, bolts, nuts, self-locking rivets, self-locking bolts, end-welded studs, and other suitable fasteners designed to withstand design loads.
1. Provide metal-backed neoprene washers under heads of fasteners bearing on weather side of panels.
 2. Use aluminum or stainless steel fasteners for exterior application and galvanized or cadmium-plated fasteners for interior applications.
 3. Locate and space fastenings in true vertical and horizontal alignment. Use proper tools to obtain controlled uniform compression for positive seal without rupture of neoprene washer.
 4. Provide fasteners with heads matching color of roofing or siding sheets by means of plastic caps or factory-applied coating.
- D. Accessories: Provide the following sheet metal accessories factory-formed of the same material in the same finish as roof and wall panels:

1. Flashings.
 2. Closers.
 3. Fillers.
 4. Metal expansion joints.
 5. Ridge covers.
 6. Fascias.
- E. Flexible Closure Strips: Closed-cell, expanded cellular rubber, self-extinguishing flexible closure strips. Cut or premold to match configuration of roofing and siding sheets. Provide closure strips where indicated or necessary to ensure weathertight construction.
- F. Sealing Tape: Pressure-sensitive 100 percent solids grey polyisobutylene compound sealing tape with release paper backing. Provide permanently elastic, nonsag, nontoxic, nonstaining tape 1/2 inch (13 mm) wide and 1/8 inch (3 mm) thick.
- G. Joint Sealant: One-part elastomeric polyurethane, polysulfide, or silicone rubber sealant as recommended by the building manufacturer.
- H. Fluoropolymer Finish: Provide shop-applied fluoropolymer finish to galvanized steel roofing and siding panels and related trim and accessory elements.
1. Clean galvanized steel with an alkaline compound, then treat with a zinc phosphate conversion coating and seal with a chromic acid rinse.
 2. Apply a 2-coat fluoropolymer coating system to pretreated steel. Coating shall consist of a specially formulated inhibitive primer applied to a dry film thickness of 0.15 mil (0.004 mm) to 0.25 mil (0.006 mm) and a fluorocarbon color coat containing not less than 70 percent polyvinylidene fluoride resin by weight applied to a dry film thickness of 0.80 mils (0.02 mm) to 1.3 mils (0.03 mm).
 - a. Color: As selected by the Architect from the manufacturer's standard colors.

2.5 SHEET METAL ACCESSORIES

- A. General: Provide coated steel sheet metal accessories with coated steel roofing and siding panels.
- B. Gutters: Form in 96 inch (2400 mm) long sections, complete with end pieces, outlet tubes, and other special pieces as required. Size in accordance with SMACNA. Join sections with riveted and soldered or sealed joints. Provide expansion-type slip joint at center of runs. Furnish gutter supports spaced 36 inches (900 mm) on center, constructed of same metal as gutters. Provide bronze, copper, or aluminum wire ball strainers at outlets. Finish to match roof fascia and rake.
- C. Downspouts: Form in 10 feet (3 m) long sections, complete with elbows and offsets. Join sections with 1-1/2 inch (38 mm) telescoping joints. Provide fasteners designed to hold downspouts securely 1 inch (25 mm) away from walls; locate fasteners at top and bottom and at approximately 60 inch (1500 mm) on center in between. Finish to match wall panels.

2.6 FABRICATION

- A. General: Design prefabricated components and necessary field connections required for erection to permit easy assembly and disassembly.
 - 1. Fabricate components in such a manner that once assembled, they may be disassembled, repackaged, and reassembled with a minimum amount of labor.
 - 2. Clearly and legibly mark each piece and part of the assembly to correspond with previously prepared erection drawings, diagrams, and instruction manuals.
- B. Structural Framing: Shop-fabricate framing components to indicated size and section with base plates, bearing plates, and other plates required for erection, welded in place. Provide holes for anchoring or connections shop-drilled or punched to template dimensions.
 - 1. Shop Connections: Provide power riveted, bolted, or welded shop connections.
 - 2. Field Connections: Provide bolted field connections.

PART 3 - EXECUTION

3.1 ERECTION

- A. Framing: Erect framing true to line, level, plumb, rigid, and secure. Level base plates to a true even plane with full bearing to supporting structures, set with double-nutted anchor rods. Use a non-metallic, nonshrinking grout to obtain uniform bearing and to maintain a level base line elevation. Moist cure grout for not less than 7 days after placement.
- B. Purlins and Girts: Provide rake or gable purlins with tight-fitting closure channels and fascias. Locate and space wall girts to suit door and window arrangements and heights. Secure purlins and girts to structural framing and hold rigidly to a straight line by sag rods.
- C. Bracing: Provide diagonal rod or angle bracing in roof and sidewalls as indicated.
 - 1. Movement-resisting frames may be used in lieu of sidewall rod bracing, to suit manufacturer's standards.
 - 2. Where diaphragm strength of roof or wall covering is adequate to resist wind forces, rod or angle bracing will not be required.
- D. Framed Openings: Provide shapes of proper design and size to reinforce openings and to carry loads and vibrations imposed, including equipment furnished under mechanical and electrical work. Securely attach to building structural frame.

3.2 ROOFING (SEE ROOF PLANS FOR EXTENT)

- A. General: Arrange and nest sidelap joints so prevailing winds blow over, not into, lapped joints. Lap ribbed or fluted sheets one full rib corrugation. Apply panels and associated items for neat and weathertight enclosure. Avoid "panel creep" or application not true to line. Protect factory finishes from damage.
 - 1. Field cutting of exterior panels by torch is not permitted.

2. Provide weatherseal under ridge cap. Flash and seal roof panels at eave and rake with rubber, neoprene, or other closures to exclude weather.
- B. Standing-Seam Roof Panel System: Fasten roof panels to purlins with concealed clip in accordance with the manufacturer's instructions.
1. Install clips at each support with self-drilling fasteners.
 2. At end laps of panels, install tape calk between panels.
 3. Install factory-calked cleats at standing-seam joints. Machine-seam cleats to the panels to provide a weathertight joint.
- C. Sheet Metal Accessories: Install gutters, downspouts, and other sheet metal accessories in accordance with manufacturer's recommendations for positive anchorage to building and weathertight mounting. Adjust operating mechanism for precise operation.
- D. Cleaning and Touch-Up: Clean component surfaces of matter that could preclude paint bond. Touch up abrasions, marks, skips, or other defects to shop-primed surfaces with same type material as shop primer.

END OF SECTION 133419

SECTION 220500 - BASIC PLUMBING MATERIALS AND METHODS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes the following:
 1. Piping materials and installation instructions common to most piping systems.
 2. Transition fittings.
 3. Dielectric fittings.
 4. Mechanical sleeve seals.
 5. Sleeves.
 6. Escutcheons.
 7. Grout.
 8. Equipment installation requirements common to equipment sections.
 9. Painting and finishing.
 10. Concrete bases.
 11. Supports and anchorages.
 12. Plumbing demolition.

1.3 DEFINITIONS

- A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct shafts, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels.
- B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.
- C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.
- D. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and in duct shafts.
- E. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.

- F. The following are industry abbreviations for plastic materials:
 - 1. ABS: Acrylonitrile-butadiene-styrene plastic.
 - 2. CPVC: Chlorinated polyvinyl chloride plastic.
 - 3. PE: Polyethylene plastic.
 - 4. PVC: Polyvinyl chloride plastic.

- G. The following are industry abbreviations for rubber materials:
 - 1. EPDM: Ethylene-propylene-diene terpolymer rubber.
 - 2. NBR: Acrylonitrile-butadiene rubber.

1.4 SUBMITTALS

- A. Product Data: For the following:
 - 1. Transition fittings.
 - 2. Dielectric fittings.
 - 3. Mechanical sleeve seals.
 - 4. Escutcheons.

- B. Welding certificates.

1.5 QUALITY ASSURANCE

- A. Steel Support Welding: Qualify processes and operators according to AWS D1.1, "Structural Welding Code--Steel."

- B. Steel Pipe Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
 - 1. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."
 - 2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.

- C. Electrical Characteristics for Mechanical Equipment: Equipment of higher electrical characteristics may be furnished provided such proposed equipment is approved in writing and connecting electrical services, circuit breakers, and conduit sizes are appropriately modified. If minimum energy ratings or efficiencies are specified, equipment shall comply with requirements.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture.

- B. Store plastic pipes protected from direct sunlight. Support to prevent sagging and bending.

1.7 COORDINATION

- A. Arrange for pipe spaces, chases, slots, and openings in building structure during progress of construction, to allow for mechanical installations.
- B. Coordinate installation of required supporting devices and set sleeves in poured-in-place concrete and other structural components as they are constructed.
- C. Coordinate requirements for access panels and doors for mechanical items requiring access that are concealed behind finished surfaces.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. In other Part 2 articles where subparagraph titles below introduce lists, the following requirements apply for product selection:
 - 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the manufacturers specified.

2.2 PIPE, TUBE, AND FITTINGS

- A. Refer to individual Division 22 piping Sections for pipe, tube, and fitting materials and joining methods.
- B. Pipe Threads: ASME B1.20.1 for factory-threaded pipe and pipe fittings.

2.3 JOINING MATERIALS

- A. Refer to individual Division 22 piping Sections for special joining materials not listed below.
- B. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.
 - 1. ASME B16.21, nonmetallic, flat, asbestos-free, 1/8-inch maximum thickness unless thickness or specific material is indicated.
 - a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
 - b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.
 - 2. AWWA C110, rubber, flat face, 1/8 inch thick, unless otherwise indicated; and full-face or ring type, unless otherwise indicated.
- C. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.
- D. Plastic, Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer, unless otherwise indicated.
- E. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.

- F. Brazing Filler Metals: AWS A5.8, BCuP Series, copper-phosphorus alloys for general-duty brazing, unless otherwise indicated; and AWS A5.8, BAg1, silver alloy for refrigerant piping, unless otherwise indicated.
- G. Welding Filler Metals: Comply with AWS D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.
- H. Solvent Cements for Joining Plastic Piping:
 - 1. ABS Piping: ASTM D 2235.
 - 2. CPVC Piping: ASTM F 493.
 - 3. PVC Piping: ASTM D 2564. Include primer according to ASTM F 656.
 - 4. PVC to ABS Piping Transition: ASTM D 3138.
- I. Fiberglass Pipe Adhesive: As furnished or recommended by pipe manufacturer.

2.4 TRANSITION FITTINGS

- A. AWWA Transition Couplings: Same size as, and with pressure rating at least equal to and with ends compatible with, piping to be joined.
 - 1. Manufacturers:
 - a. Cascade Waterworks Mfg. Co.
 - b. Dresser Industries, Inc.; DMD Div.
 - c. Ford Meter Box Company, Incorporated (The); Pipe Products Div.
 - d. JCM Industries.
 - e. Smith-Blair, Inc.
 - f. Viking Johnson.
 - 2. Underground Piping NPS 1-1/2 and Smaller: Manufactured fitting or coupling.
 - 3. Underground Piping NPS 2 and Larger: AWWA C219, metal sleeve-type coupling.
 - 4. Aboveground Pressure Piping: Pipe fitting.
- B. Plastic-to-Metal Transition Fittings: PVC one-piece fitting with manufacturer's Schedule 80 equivalent dimensions; one end with threaded brass insert, and one solvent-cement-joint end.
- C. Plastic-to-Metal Transition Adaptors: One-piece fitting with manufacturer's SDR 11 equivalent dimensions; one end with threaded brass insert, and one solvent-cement-joint end.
- D. Plastic-to-Metal Transition Unions: MSS SP-107, PVC four-part union. Include brass end, solvent-cement-joint end, rubber O-ring, and union nut.
- E. Flexible Transition Couplings for Underground Nonpressure Drainage Piping: ASTM C 1173 with elastomeric sleeve, ends same size as piping to be joined, and corrosion-resistant metal band on each end.
 - 1. Manufacturers:
 - a. Cascade Waterworks Mfg. Co.
 - b. Fernco, Inc.
 - c. Mission Rubber Company.
 - d. Plastic Oddities, Inc.

2.5 DIELECTRIC FITTINGS

- A. Description: Combination fitting of copper alloy and ferrous materials with threaded, solder-joint, plain, or weld-neck end connections that match piping system materials.
- B. Insulating Material: Suitable for system fluid, pressure, and temperature.
- C. Dielectric Unions: Factory-fabricated, union assembly, for 250-psig minimum working pressure at 180 deg F.
 - 1. Manufacturers:
 - a. Capitol Manufacturing Co.
 - b. Central Plastics Company.
 - c. Eclipse, Inc.
 - d. Epco Sales, Inc.
 - e. Hart Industries, International, Inc.
 - f. Watts Industries, Inc.; Water Products Div.
 - g. Zurn Industries, Inc.; Wilkins Div.
- D. Dielectric Flanges: Factory-fabricated, companion-flange assembly, for 150- or 300-psig minimum working pressure as required to suit system pressures.
 - 1. Manufacturers:
 - a. Capitol Manufacturing Co.
 - b. Central Plastics Company.
 - c. Epco Sales, Inc.
 - d. Watts Industries, Inc.; Water Products Div.
- E. Dielectric-Flange Kits: Companion-flange assembly for field assembly. Include flanges, full-face- or ring-type neoprene or phenolic gasket, phenolic or polyethylene bolt sleeves, phenolic washers, and steel backing washers.
 - 1. Manufacturers:
 - a. Advance Products & Systems, Inc.
 - b. Calpico, Inc.
 - c. Central Plastics Company.
 - d. Pipeline Seal and Insulator, Inc.
 - 2. Separate companion flanges and steel bolts and nuts shall have 150- or 300-psig minimum working pressure where required to suit system pressures.
- F. Dielectric Couplings: Galvanized-steel coupling with inert and noncorrosive, thermoplastic lining; threaded ends; and 300-psig minimum working pressure at 225 deg F.
- G. Dielectric Nipples: Electroplated steel nipple with inert and noncorrosive, thermoplastic lining; plain, threaded, or grooved ends; and 300-psig minimum working pressure at 225 deg F.
 - 1. Manufacturers:
 - a. Perfection Corp.
 - b. Precision Plumbing Products, Inc.
 - c. Sioux Chief Manufacturing Co., Inc.
 - d. Victaulic Co. of America.

2.6 MECHANICAL SLEEVE SEALS

- A. Description: Modular sealing element unit, designed for field assembly, to fill annular space between pipe and sleeve.
 - 1. Manufacturers:
 - a. Advance Products & Systems, Inc.
 - b. Calpico, Inc.
 - c. Metraflex Co.
 - d. Pipeline Seal and Insulator, Inc.
 - 2. Sealing Elements: EPDM interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
 - 3. Pressure Plates: Carbon steel. Include two for each sealing element.
 - 4. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements. Include one for each sealing element.

2.7 SLEEVES

- A. Galvanized-Steel Sheet: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint.
- B. Steel Pipe: ASTM A 53, Type E, Grade B, Schedule 40, galvanized, plain ends.
- C. Cast Iron: Cast or fabricated "wall pipe" equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.
- D. Stack Sleeve Fittings: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring and bolts and nuts for membrane flashing.
 - 1. Underdeck Clamp: Clamping ring with set screws.
- E. Molded PVC: Permanent, with nailing flange for attaching to wooden forms.
- F. PVC Pipe: ASTM D 1785, Schedule 40.
- G. Molded PE: Reusable, PE, tapered-cup shaped, and smooth-outer surface with nailing flange for attaching to wooden forms.

2.8 ESCUTCHEONS

- A. Description: Manufactured wall and ceiling escutcheons and floor plates, with an ID to closely fit around pipe, tube, and insulation of insulated piping and an OD that completely covers opening.
- B. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with polished chrome-plated finish.
- C. One-Piece, Cast-Brass Type: With set screw.
 - 1. Finish: Polished chrome-plated.
- D. One-Piece, Floor-Plate Type: Cast-iron floor plate.

2.9 GROUT

- A. Description: ASTM C 1107, Grade B, nonshrink and nonmetallic, dry hydraulic-cement grout.
 - 1. Characteristics: Post-hardening, volume-adjusting, nonstaining, noncorrosive, nongaseous, and recommended for interior and exterior applications.
 - 2. Design Mix: 5000-psi, 28-day compressive strength.
 - 3. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 PIPING SYSTEMS - COMMON REQUIREMENTS

- A. Install piping according to the following requirements and Division 22 Sections specifying piping systems.
- B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.
- C. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.
- D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- F. Install piping to permit valve servicing.
- G. Install piping at indicated slopes.
- H. Install piping free of sags and bends.
- I. Install fittings for changes in direction and branch connections.
- J. Install piping to allow application of insulation.
- K. Select system components with pressure rating equal to or greater than system operating pressure.
- L. Install escutcheons for penetrations of walls, ceilings, and floors according to the following:
 - 1. New Piping:
 - a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.

- b. Chrome-Plated Piping: One-piece, cast-brass type with polished chrome-plated finish.
 - c. Insulated Piping: One-piece, stamped-steel type with spring clips.
 - d. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, cast-brass type with polished chrome-plated finish.
 - e. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece, cast-brass type with polished chrome-plated finish.
 - f. Bare Piping in Unfinished Service Spaces: One-piece, cast-brass type with polished chrome-plated finish.
 - g. Bare Piping in Equipment Rooms: One-piece, cast-brass type.
 - h. Bare Piping at Floor Penetrations in Equipment Rooms: One-piece, floor-plate type.
- M. Install sleeves for pipes passing through concrete and masonry walls and concrete floor and roof slabs.
- 1. Cut sleeves to length for mounting flush with both surfaces.
 - a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches above finished floor level. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.
 - 2. Install sleeves in new walls and slabs as new walls and slabs are constructed.
 - 3. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation. Use the following sleeve materials:
 - a. Steel Pipe Sleeves: For pipes smaller than NPS 6.
 - b. Steel Sheet Sleeves: For pipes NPS 6 and larger, penetrating gypsum-board partitions.
 - c. Stack Sleeve Fittings: For pipes penetrating floors with membrane waterproofing. Secure flashing between clamping flanges. Install section of cast-iron soil pipe to extend sleeve to 2 inches above finished floor level. Refer to Division 7 Sections for flashing materials and installation.
 - 1) Seal space outside of sleeve fittings with grout.
 - 4. Except for underground wall penetrations, seal annular space between sleeve and pipe or pipe insulation, using joint sealants appropriate for size, depth, and location of joint. Refer to Division 7 Section "Joint Sealants" for materials and installation.
- N. Aboveground, Exterior-Wall Pipe Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.
- 1. Install steel pipe for sleeves smaller than 6 inches in diameter.
 - 2. Install cast-iron "wall pipes" for sleeves 6 inches and larger in diameter.
 - 3. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

- O. Underground, Exterior-Wall Pipe Penetrations: Install cast-iron "wall pipes" for sleeves. Seal pipe penetrations using mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.
 - 1. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.
- P. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Refer to Division 7 Sections for materials and installation.
- Q. Verify final equipment locations for roughing-in.
- R. Refer to equipment specifications in other Sections of these Specifications for roughing-in requirements.

3.2 PIPING JOINT CONSTRUCTION

- A. Join pipe and fittings according to the following requirements and Division 22 Sections specifying piping systems.
- B. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- C. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
- D. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.
- E. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter, using copper-phosphorus brazing filler metal complying with AWS A5.8.
- F. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
 - 1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
 - 2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.
- G. Welded Joints: Construct joints according to AWS D10.12, using qualified processes and welding operators according to Part 1 "Quality Assurance" Article.
- H. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

- I. Plastic Piping Solvent-Cement Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:
 - 1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
 - 2. ABS Piping: Join according to ASTM D 2235 and ASTM D 2661 Appendixes.
 - 3. CPVC Piping: Join according to ASTM D 2846/D 2846M Appendix.
 - 4. PVC Pressure Piping: Join schedule number ASTM D 1785, PVC pipe and PVC socket fittings according to ASTM D 2672. Join other-than-schedule-number PVC pipe and socket fittings according to ASTM D 2855.
 - 5. PVC Nonpressure Piping: Join according to ASTM D 2855.
 - 6. PVC to ABS Nonpressure Transition Fittings: Join according to ASTM D 3138 Appendix.
- J. Plastic Pressure Piping Gasketed Joints: Join according to ASTM D 3139.
- K. Plastic Nonpressure Piping Gasketed Joints: Join according to ASTM D 3212.
- L. PE Piping Heat-Fusion Joints: Clean and dry joining surfaces by wiping with clean cloth or paper towels. Join according to ASTM D 2657.
 - 1. Plain-End Pipe and Fittings: Use butt fusion.
 - 2. Plain-End Pipe and Socket Fittings: Use socket fusion.
- M. Fiberglass Bonded Joints: Prepare pipe ends and fittings, apply adhesive, and join according to pipe manufacturer's written instructions.

3.3 PIPING CONNECTIONS

- A. Make connections according to the following, unless otherwise indicated:
 - 1. Install unions, in piping NPS 2 and smaller, adjacent to each valve and at final connection to each piece of equipment.
 - 2. Install flanges, in piping NPS 2-1/2 and larger, adjacent to flanged valves and at final connection to each piece of equipment.
 - 3. Dry Piping Systems: Install dielectric unions and flanges to connect piping materials of dissimilar metals.
 - 4. Wet Piping Systems: Install dielectric coupling and nipple fittings to connect piping materials of dissimilar metals.

3.4 EQUIPMENT INSTALLATION - COMMON REQUIREMENTS

- A. Install equipment to allow maximum possible headroom unless specific mounting heights are not indicated.
- B. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated.
- C. Install mechanical equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference to other installations. Extend grease fittings to accessible locations.
- D. Install equipment to allow right of way for piping installed at required slope.

3.5 PAINTING

- A. Painting of mechanical systems, equipment, and components is specified in Division 9 Section "Painting".
- B. Damage and Touchup: Repair marred and damaged factory-painted finishes with materials and procedures to match original factory finish.

3.6 CONCRETE BASES

- A. Concrete Bases: Anchor equipment to concrete base according to equipment manufacturer's written instructions and according to seismic codes at Project.
 - 1. Construct concrete bases of dimensions indicated, but not less than 4 inches larger in both directions than supported unit.
 - 2. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of the base.
 - 3. Install epoxy-coated anchor bolts for supported equipment that extend through concrete base, and anchor into structural concrete floor.
 - 4. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 - 5. Install anchor bolts to elevations required for proper attachment to supported equipment.
 - 6. Install anchor bolts according to anchor-bolt manufacturer's written instructions.
 - 7. Use concrete and reinforcement as specified in Division 3 Section "Cast-in-Place Concrete".

3.7 ERECTION OF METAL SUPPORTS AND ANCHORAGES

- A. Refer to Division 5 Section "Metal Fabrications" for structural steel.
- B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor mechanical materials and equipment.
- C. Field Welding: Comply with AWS D1.1.

3.8 ERECTION OF WOOD SUPPORTS AND ANCHORAGES

- A. Cut, fit, and place wood grounds, nailers, blocking, and anchorages to support, and anchor mechanical materials and equipment.
- B. Select fastener sizes that will not penetrate members if opposite side will be exposed to view or will receive finish materials. Tighten connections between members. Install fasteners without splitting wood members.
- C. Attach to substrates as required to support applied loads.

3.9 GROUTING

- A. Mix and install grout for mechanical equipment base bearing surfaces, pump and other equipment base plates, and anchors.
- B. Clean surfaces that will come into contact with grout.
- C. Provide forms as required for placement of grout.
- D. Avoid air entrapment during placement of grout.
- E. Place grout, completely filling equipment bases.
- F. Place grout on concrete bases and provide smooth bearing surface for equipment.
- G. Place grout around anchors.
- H. Cure placed grout.

3.10 PLUMBING DEMOLITION

- A. Refer to Sections "Cutting and Patching" and "Selective Demolition" for general demolition requirements and procedures.
- B. Disconnect, demolish, and remove plumbing systems, equipment, and components indicated to be removed.
 - 1. Piping to Be Removed: Remove portion of piping indicated to be removed and cap or plug remaining piping with same or compatible piping material.
 - 2. Piping to Be Abandoned in Place: Drain piping and cap or plug piping with same or compatible piping material.
 - 3. Equipment to Be Removed: Disconnect and cap services and remove equipment.
 - 4. Equipment to Be Removed and Reinstalled: Disconnect and cap services and remove, clean, and store equipment; when appropriate, reinstall, reconnect, and make equipment operational.
 - 5. Equipment to Be Removed and Salvaged: Disconnect and cap services and remove equipment and deliver to Owner.
- C. If pipe, insulation, or equipment to remain is damaged in appearance or is unserviceable, remove damaged or unserviceable portions and replace with new products of equal capacity and quality.

END OF SECTION 220500

SECTION 220519 - METERS AND GAGES FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes the following meters and gages for mechanical systems:
 1. Thermometers.
 2. Gages.
 3. Test plugs.

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated; include performance curves.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 LIQUID-IN-GLASS THERMOMETERS

- A. Manufacturers:
 1. Palmer - Wahl Instruments Inc.
 2. Trerice, H. O. Co.
 3. Weiss Instruments, Inc.
 4. Weksler Instruments Operating Unit; Dresser Industries; Instrument Div.
- B. Case: Interior Locations: die-cast aluminum, brass, or molded polyester, 7 inches long. Exterior Locations: die-cast coated aluminum, weatherproof, 7 inches long.
- C. Tube: Red or blue reading, organic-liquid filled, with magnifying lens.
- D. Tube Background: Satin-faced, nonreflective aluminum with permanently etched scale markings.
- E. Window: Glass.

- F. Connector: Adjustable type, 180 degrees in vertical plane, 360 degrees in horizontal plane, with locking device.
- G. Stem: Copper-plated steel, aluminum, or brass for thermowell installation and of length to suit installation.
- H. Accuracy: Plus or minus 1 percent of range or plus or minus 1 scale division to maximum of 1.5 percent of range.
- I. Thermowells: Pressure-tight, socket-type metal fitting made for insertion into piping and of type, diameter, and length required to hold thermometer.

2.2 PRESSURE GAGES

- A. Manufacturers:
 1. AMETEK, Inc.; U.S. Gauge Div.
 2. Ashcroft Commercial Instrument Operations; Dresser Industries; Instrument Div.
 3. Ernst Gage Co.
 4. Eugene Ernst Products Co.
 5. KOBOLD Instruments, Inc.
 6. Marsh Bellofram.
 7. Miljoco Corp.
 8. Noshok, Inc.
 9. Palmer - Wahl Instruments Inc.
 10. REO TEMP Instrument Corporation.
 11. Trerice, H. O. Co.
 12. Weiss Instruments, Inc.
 13. Weksler Instruments Operating Unit; Dresser Industries; Instrument Div.
 14. WIKA Instrument Corporation.
 15. Winters Instruments.

- B. Direct-Mounting, Dial-Type Pressure Gages: Indicating-dial type complying with ASME B40.100.
 1. Case: Dry type. Interior locations: drawn steel or cast aluminum, 4-1/2-inch diameter. Exterior locations: stainless steel, weatherproof, 2-1/2-inch diameter.
 2. Pressure-Element Assembly: Bourdon tube, unless otherwise indicated.
 3. Pressure Connection: Brass, NPS 1/4, bottom-outlet type unless back-outlet type is indicated.
 4. Movement: Mechanical, with link to pressure element and connection to pointer.
 5. Dial: Satin-faced, nonreflective aluminum with permanently etched scale markings.
 6. Pointer: Red or other dark-color metal.
 7. Window: Glass.
 8. Ring: Metal.
 9. Accuracy: Grade B, plus or minus 2 percent of middle half scale.
 10. Vacuum-Pressure Range: 30-in. Hg of vacuum to 15 psig of pressure.
 11. Range for Fluids under Pressure: Two times operating pressure.

- C. Pressure-Gage Fittings:
 1. Valves: NPS 1/4 brass or stainless-steel needle type.

2. Syphons: NPS 1/4 coil of brass tubing with threaded ends.
3. Snubbers: ASME B40.5, NPS 1/4 brass bushing with corrosion-resistant, porous-metal disc of material suitable for system fluid and working pressure.

2.3 TEST PLUGS

- A. Manufacturers:
 1. Flow Design, Inc.
 2. MG Piping Products Co.
 3. National Meter, Inc.
 4. Peterson Equipment Co., Inc.
 5. Sisco Manufacturing Co.
 6. Trerice, H. O. Co.
 7. Watts Industries, Inc.; Water Products Div.
- B. Description: Corrosion-resistant brass or stainless-steel body with core inserts and gasketed and threaded cap, with extended stem for units to be installed in insulated piping.
- C. Minimum Pressure and Temperature Rating: 500 psig at 200 deg F.
- D. Core Inserts: One or two self-sealing rubber valves.
 1. Insert material for air, water, oil, or gas service at 20 to 200 deg F shall be CR.
 2. Insert material for air or water service at minus 30 to plus 275 deg F shall be EPDM.

PART 3 - EXECUTION

3.1 APPLICATIONS

- A. Install thermometers, gages, and test plugs as indicated on the plans and other specification sections.
- B. Provide the following temperature ranges for thermometers:
 1. Domestic Hot Water: 30 to 180 deg F, with 2-degree scale divisions.
 2. Domestic Cold Water: 0 to 100 deg F, with 2-degree scale divisions.

3.2 INSTALLATIONS

- A. Install direct-mounting thermometers and adjust vertical and tilted positions.
- B. Install thermowells with socket extending to center of pipe and in vertical position in piping tees where thermometers are indicated.
- C. Install direct-mounting pressure gages in piping tees with pressure gage located on pipe at most readable position.
- D. Install needle valve for each pressure gauge.

3.3 CONNECTIONS

- A. Install meters and gages adjacent to machines and equipment to allow service and maintenance for meters, gages, machines, and equipment.

3.4 ADJUSTING

- A. Adjust faces of meters and gages to proper angle for best visibility.

END OF SECTION 220519

SECTION 220523 – VALVES FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes general-duty valves.
- B. Related Sections include the following:
 - 1. Division 22 piping Sections for specialty valves applicable to those Sections only.

1.3 SUBMITTALS

- A. Product Data: For each type of valve indicated. Include body, seating, and trim materials; valve design; pressure and temperature classifications; end connections; arrangement; dimensions; and required clearances. Include list indicating valve and its application. Include rated capacities; shipping, installed, and operating weights; furnished specialties; and accessories.

1.4 QUALITY ASSURANCE

- A. ASME Compliance: ASME B31.1 for power piping valves and ASME B31.9 for building services piping valves.
- B. ASME Compliance for Ferrous Valves: ASME B16.10 and ASME B16.34 for dimension and design criteria.
- C. NSF Compliance: NSF 61 for valve materials for potable-water service.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Prepare valves for shipping as follows:
 - 1. Protect internal parts against rust and corrosion.
 - 2. Protect threads, flange faces, grooves, and weld ends.
 - 3. Set angle, gate, and globe valves closed to prevent rattling.
 - 4. Set ball and plug valves open to minimize exposure of functional surfaces.
 - 5. Block check valves in either closed or open position.
- B. Use the following precautions during storage:
 - 1. Maintain valve end protection.
 - 2. Store valves indoors and maintain at higher than ambient dew-point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. In other Part 2 articles where subparagraph titles below introduce lists, the following requirements apply for product selection:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by the manufacturers specified.

2.2 VALVES, GENERAL

- A. Refer to Part 3 "Valve Applications" Article for applications of valves.
- B. Bronze Valves: NPS 2 and smaller with threaded ends, unless otherwise indicated.
- C. Ferrous Valves: NPS 2-1/2 and larger with flanged ends, unless otherwise indicated.
- D. Valve Pressure and Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.
- E. Valve Sizes: Same as upstream pipe, unless otherwise indicated.
- F. Valve Actuators:
 - 1. Chainwheel: For attachment to valves, of size and mounting height, as indicated in the "Valve Installation" Article in Part 3.
 - 2. Handwheel: For valves other than quarter-turn types.
 - 3. Lever Handle: For quarter-turn valves NPS 6 and smaller, except plug valves.
- G. Extended Valve Stems: On insulated valves.
- H. Valve Flanges: ASME B16.1 for cast-iron valves, ASME B16.5 for steel valves, and ASME B16.24 for bronze valves.
- I. Valve Grooved Ends: AWWA C606.
 - 1. Solder Joint: With sockets according to ASME B16.18.
 - a. Caution: Use solder with melting point below 840 deg F for angle, check, gate, and globe valves; below 421 deg F for ball valves.
 - 2. Threaded: With threads according to ASME B1.20.1.

2.3 COPPER-ALLOY BALL VALVES

- A. Manufacturers:
 - 1. Two-Piece, Copper-Alloy Ball Valves:
 - a. Conbraco Industries, Inc.; Apollo Div.
 - b. Crane Co.; Crane Valve Group; Crane Valves.
 - c. Crane Co.; Crane Valve Group; Jenkins Valves.
 - d. Crane Co.; Crane Valve Group; Stockham Div.
 - e. DynaQuip Controls.
 - f. Flow-Tek, Inc.

- g. Grinnell Corporation.
- h. Hammond Valve.
- i. Honeywell Braukmann.
- j. Jamesbury, Inc.
- k. Jomar International, LTD.
- l. Kitz Corporation of America.
- m. Legend Valve & Fitting, Inc.
- n. Milwaukee Valve Company.
- o. Nexus Valve Specialties.
- p. NIBCO INC.
- q. R & M Energy Systems (Borger, TX).
- r. Red-White Valve Corp.
- s. Richards Industries; Marwin Ball Valves.
- t. Watts Industries, Inc.; Water Products Div.

B. Copper-Alloy Ball Valves, General: MSS SP-110.

C. Two-Piece, Copper-Alloy Ball Valves: Brass or bronze body with regular port, chrome-plated bronze ball; PTFE or TFE seats; and 600-psig minimum CWP rating and blowout-proof stem.

2.4 BRONZE CHECK VALVES

A. Manufacturers:

- 1. Type 2, Bronze, Lift Check Valves with Nonmetallic Disc:
 - a. Cincinnati Valve Co.
 - b. Crane Co.; Crane Valve Group; Crane Valves.
 - c. Crane Co.; Crane Valve Group; Stockham Div.
 - d. Red-White Valve Corp.
 - e. Walworth Co.
- 2. Type 4, Bronze, Swing Check Valves with Nonmetallic Disc:
 - a. American Valve, Inc.
 - b. Cincinnati Valve Co.
 - c. Crane Co.; Crane Valve Group; Crane Valves.
 - d. Crane Co.; Crane Valve Group; Jenkins Valves.
 - e. Crane Co.; Crane Valve Group; Stockham Div.
 - f. Grinnell Corporation.
 - g. Hammond Valve.
 - h. Kitz Corporation of America.
 - i. Legend Valve & Fitting, Inc.
 - j. Milwaukee Valve Company.
 - k. NIBCO INC.
 - l. Powell, Wm. Co.
 - m. Red-White Valve Corp.
 - n. Walworth Co.
 - o. Watts Industries, Inc.; Water Products Div.

B. Bronze Check Valves, General: MSS SP-80.

- C. Type 2, Class 125, Bronze, Lift Check Valves: Bronze body and seat, with nonmetallic disc.
- D. Type 4, Class 125, Bronze, Swing Check Valves: Bronze body and seat, with nonmetallic disc.

2.5 CAST-IRON GATE VALVES

- A. Manufacturers:
 - 1. Type I, Cast-Iron, Rising-Stem Gate Valves:
 - a. Cincinnati Valve Co.
 - b. Crane Co.; Crane Valve Group; Crane Valves.
 - c. Crane Co.; Crane Valve Group; Jenkins Valves.
 - d. Crane Co.; Crane Valve Group; Stockham Div.
 - e. Grinnell Corporation.
 - f. Hammond Valve.
 - g. Kitz Corporation of America.
 - h. Legend Valve & Fitting, Inc.
 - i. Milwaukee Valve Company.
 - j. NIBCO INC.
 - k. Powell, Wm. Co.
 - l. Red-White Valve Corp.
 - m. Walworth Co.
 - n. Watts Industries, Inc.; Water Products Div.
- B. Cast-Iron Gate Valves, General: MSS SP-70, Type I.
- C. Class 125, OS&Y, Bronze-Mounted, Cast-Iron Gate Valves: Cast-iron body with bronze trim, rising stem, and solid-wedge disc.

2.6 CHAINWHEEL ACTUATORS

- A. Available Manufacturers:
- B. Manufacturers:
 - 1. Babbitt Steam Specialty Co.
 - 2. Roto Hammer Industries, Inc.
- C. Description: Valve actuation assembly with sprocket rim, brackets, and chain.
 - 1. Sprocket Rim with Chain Guides: Cast iron of type and size required for valve.
 - 2. Brackets: Type, number, size, and fasteners required to mount actuator on valve.
 - 3. Chain: Hot-dip, galvanized steel, of size required to fit sprocket rim.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine piping system for compliance with requirements for installation tolerances and other conditions affecting performance.

1. Proceed with installation only after unsatisfactory conditions have been corrected.
- B. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.

3.2 VALVE APPLICATIONS

- A. Refer to piping Sections for specific valve applications. If valve applications are not indicated, use the following:
 1. Shutoff Service: Ball or gate valves.
 2. Pump Discharge: Spring-loaded, lift-disc check valves.
- B. Domestic Water Piping: Use the following types of valves:
 1. Ball Valves, NPS 2 and Smaller: Two-piece, 600-psig CWP rating, copper alloy.
 2. Swing Check Valves, NPS 2 and Smaller: Type 4, Class 125 bronze.
 3. Swing Check Valves, NPS 2-1/2 and Larger: Type II, Class 125, gray iron.
 4. Gate Valves, NPS 2-1/2 and Larger: Type I, Class 125 OS&Y, bronze-mounted cast iron.

3.3 VALVE INSTALLATION

- A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.
- C. Locate valves for easy access and provide separate support where necessary.
- D. Install valves in horizontal piping with stem at or above center of pipe.
- E. Install valves in position to allow full stem movement.
- F. Install chainwheel operators on valves NPS 4 and larger and more than 96 inches above floor. Extend chains to 60 inches above finished floor elevation.
- G. Install check valves for proper direction of flow and as follows:
 1. Swing Check Valves: IN horizontal position with hinge pin level.
 2. Dual-Plate Check Valves: In horizontal or vertical position, between flanges.
 3. Lift Check Valves: With stem upright and plumb.

3.4 JOINT CONSTRUCTION

- A. Refer to Division 22 Section "Basic Plumbing Materials and Methods" for basic piping joint construction.
- B. Grooved Joints: Assemble joints with keyed coupling housing, gasket, lubricant, and bolts according to coupling and fitting manufacturer's written instructions.

- C. Soldered Joints: Use ASTM B 813, water-flushable, lead-free flux; ASTM B 32, lead-free-alloy solder; and ASTM B 828 procedure, unless otherwise indicated.

3.5 ADJUSTING

- A. Adjust or replace valve packing after piping systems have been tested and put into service but before final adjusting and balancing. Replace valves if persistent leaking occurs.

END OF SECTION 220523

SECTION 220529 - HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes hangers and supports for mechanical system piping and equipment.
- B. Related Sections include the following:
 - 1. Division 5 Section "Metal Fabrications" for materials for attaching hangers and supports to building structure.

1.3 DEFINITIONS

- A. MSS: Manufacturers Standardization Society for the Valve and Fittings Industry.
- B. Terminology: As defined in MSS SP-90, "Guidelines on Terminology for Pipe Hangers and Supports."

1.4 PERFORMANCE REQUIREMENTS

- A. Design channel support systems for piping to support multiple pipes capable of supporting combined weight of supported systems, system contents, and test water.
- B. Design heavy-duty steel trapezes for piping to support multiple pipes capable of supporting combined weight of supported systems, system contents, and test water.

1.5 SUBMITTALS

- A. Product Data: For each type of pipe hanger, channel support system component, and thermal-hanger shield insert indicated.
- B. Shop Drawings: Signed and sealed by a qualified professional engineer for multiple piping supports and trapeze hangers. Include design calculations and indicate size and characteristics of components and fabrication details.
- C. Welding Certificates: Copies of certificates for welding procedures and operators.

1.6 QUALITY ASSURANCE

- A. Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
- B. Engineering Responsibility: Design and preparation of Shop Drawings and calculations for each multiple pipe support and trapeze by a qualified professional engineer.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified:
 - 1. Pipe Hangers:
 - a. AAA Technology and Specialties Co., Inc.
 - b. B-Line Systems, Inc.
 - c. Carpenter & Patterson, Inc.
 - d. Empire Tool & Manufacturing Co., Inc.
 - e. Globe Pipe Hanger Products, Inc.
 - f. Grinnell Corp.
 - g. GS Metals Corp.
 - h. Michigan Hanger Co., Inc.
 - i. National Pipe Hanger Corp.
 - j. PHD Manufacturing, Inc.
 - k. PHS Industries, Inc.
 - l. Piping Technology & Products, Inc.
 - 2. Channel Support Systems:
 - a. B-Line Systems, Inc.
 - b. Grinnell Corp.; Power-Strut Unit.
 - c. GS Metals Corp.
 - d. Michigan Hanger Co., Inc.; O-Strut Div.
 - e. National Pipe Hanger Corp.
 - f. Thomas & Betts Corp.
 - g. Unistrut Corp.
 - h. Wesanco, Inc.
 - 3. Thermal-Hanger Shield Inserts:
 - a. Carpenter & Patterson, Inc.
 - b. Michigan Hanger Co., Inc.
 - c. PHS Industries, Inc.
 - d. Pipe Shields, Inc.
 - e. Rilco Manufacturing Co., Inc.
 - f. Value Engineered Products, Inc.
 - 4. Powder-Actuated Fastener Systems:
 - a. Gunnebo Fastening Corp.
 - b. Hilti, Inc.
 - c. ITW Ramset/Red Head.
 - d. Masterset Fastening Systems, Inc.

2.2 MANUFACTURED UNITS

- A. Pipe Hangers, Supports, and Components: MSS SP-58, factory-fabricated components. Refer to "Hanger and Support Applications" Article in Part 3 for where to use specific hanger and support types.
 - 1. General:
 - a. Interior hangers, rods, supports, etc. to be corrosion resistant, hot dipped galvanized steel.
 - b. Exterior hangers, rods, supports, etc. to be corrosion resistant, Type 304 or 316 stainless steel.
 - 2. Nonmetallic Coatings: On attachments for electrolytic protection where attachments are in direct contact with copper tubing.
 - 3. All attachments to precast hollow-core concrete slabs shall comply with slab manufacturer's installation instructions.
- B. Channel Support Systems: MFMA-2, factory-fabricated components for field assembly.
 - 1. Coatings: Manufacturer's standard finish, unless bare metal surfaces are indicated.
 - 2. Nonmetallic Coatings: On attachments for electrolytic protection where attachments are in direct contact with copper tubing.
- C. Thermal-Hanger Shield Inserts: 100-psi minimum compressive-strength insulation, encased in sheet metal shield.
 - 1. Material for Cold Piping: ASTM C 552, Type I cellular glass or water-repellent-treated, ASTM C 533, Type I calcium silicate with vapor barrier.
 - 2. Material for Cold Piping: ASTM C 552, Type I cellular glass with vapor barrier.
 - 3. Material for Cold Piping: Water-repellent-treated, ASTM C 533, Type I calcium silicate with vapor barrier.
 - 4. Material for Hot Piping: ASTM C 552, Type I cellular glass or water-repellent-treated, ASTM C 533, Type I calcium silicate.
 - 5. Material for Hot Piping: ASTM C 552, Type I cellular glass.
 - 6. Material for Hot Piping: Water-repellent-treated, ASTM C 533, Type I calcium silicate.
 - 7. For Trapeze or Clamped System: Insert and shield cover entire circumference of pipe.
 - 8. For Clevis or Band Hanger: Insert and shield cover lower 180 degrees of pipe.
 - 9. Insert Length: Extend 2 inches beyond sheet metal shield for piping operating below ambient air temperature.

2.3 MISCELLANEOUS MATERIALS

- A. Powder-Actuated Drive-Pin Fasteners: Powder-actuated-type, drive-pin attachments with pull-out and shear capacities appropriate for supported loads and building materials where used.
- B. Mechanical-Anchor Fasteners: Insert-type attachments with pull-out and shear capacities appropriate for supported loads and building materials where used.

- C. Structural Steel: ASTM A 36/A 36M, steel plates, shapes, and bars, black and galvanized.
- D. Grout: ASTM C 1107, Grade B, factory-mixed and -packaged, nonshrink and nonmetallic, dry, hydraulic-cement grout.
 - 1. Characteristics: Post hardening and volume adjusting; recommended for both interior and exterior applications.
 - 2. Properties: Nonstaining, noncorrosive, and nongaseous.
 - 3. Design Mix: 5000-psi, 28-day compressive strength.

PART 3 - EXECUTION

3.1 HANGER AND SUPPORT APPLICATIONS

- A. General: Interior hangers, rods, supports, etc. to be corrosion resistant, hot dipped galvanized steel. Exterior hangers, rods, supports, etc. to be corrosion resistant, Type 304 or 316 stainless steel.
- B. All attachments to precast hollow-core concrete slabs shall comply with slab manufacturer's installation instructions.
- C. Specific hanger requirements are specified in Sections specifying equipment and systems.
- D. Comply with MSS SP-69 for pipe hanger selections and applications that are not specified in piping system Specification Sections.
- E. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Specification Sections, install the following types:
 - 1. Adjustable Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated stationary pipes, NPS 1/2 to NPS 30.
 - 2. Yoke-Type Pipe Clamps (MSS Type 2): For suspension of 120 to 450 deg F pipes, NPS 4 to NPS 16, requiring up to 4 inches of insulation.
 - 3. Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes, NPS 3/4 to NPS 24, requiring clamp flexibility and up to 4 inches of insulation.
 - 4. Steel Pipe Clamps (MSS Type 4): For suspension of cold and hot pipes, NPS 1/2 to NPS 24, if little or no insulation is required.
 - 5. Pipe Hangers (MSS Type 5): For suspension of pipes, NPS 1/2 to NPS 4, to allow off-center closure for hanger installation before pipe erection.
 - 6. Adjustable Swivel Split- or Solid-Ring Hangers (MSS Type 6): For suspension of noninsulated stationary pipes, NPS 3/4 to NPS 8.
 - 7. Adjustable Steel Band Hangers (MSS Type 7): For suspension of noninsulated stationary pipes, NPS 1/2 to NPS 8.
 - 8. Adjustable Band Hangers (MSS Type 9): For suspension of noninsulated stationary pipes, NPS 1/2 to NPS 8.
 - 9. Adjustable Swivel-Ring Band Hangers (MSS Type 10): For suspension of noninsulated stationary pipes, NPS 1/2 to NPS 2.

10. Split Pipe-Ring with or without Turnbuckle-Adjustment Hangers (MSS Type 11): For suspension of noninsulated stationary pipes, NPS 3/8 to NPS 8.
 11. Extension Hinged or Two-Bolt Split Pipe Clamps (MSS Type 12): For suspension of noninsulated stationary pipes, NPS 3/8 to NPS 3.
 12. U-Bolts (MSS Type 24): For support of heavy pipe, NPS 1/2 to NPS 30.
 13. Clips (MSS Type 26): For support of insulated pipes not subject to expansion or contraction.
 14. Pipe Saddle Supports (MSS Type 36): For support of pipes, NPS 4 to NPS 36, with steel pipe base stanchion support and cast-iron floor flange.
 15. Pipe Stanchion Saddles (MSS Type 37): For support of pipes, NPS 4 to NPS 36, with steel pipe base stanchion support and cast-iron floor flange and with U-bolt to retain pipe.
 16. Adjustable Pipe Saddle Supports (MSS Type 38): For stanchion-type support for pipes, NPS 2-1/2 to NPS 36, if vertical adjustment is required, with steel pipe base stanchion support and cast-iron floor flange.
 17. Single Pipe Rolls (MSS Type 41): For suspension of pipes, NPS 1 to NPS 30, from two rods if longitudinal movement caused by expansion and contraction might occur.
 18. Adjustable Roller Hangers (MSS Type 43): For suspension of pipes, NPS 2-1/2 to NPS 20, from single rod if horizontal movement caused by expansion and contraction might occur.
 19. Complete Pipe Rolls (MSS Type 44): For support of pipes, NPS 2 to NPS 42, if longitudinal movement caused by expansion and contraction might occur but vertical adjustment is not necessary.
 20. Pipe Roll and Plate Units (MSS Type 45): For support of pipes, NPS 2 to NPS 24, if small horizontal movement caused by expansion and contraction might occur and vertical adjustment is not necessary.
 21. Adjustable Pipe Roll and Base Units (MSS Type 46): For support of pipes, NPS 2 to NPS 30, if vertical and lateral adjustment during installation might be required in addition to expansion and contraction.
- F. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Specification Sections, install the following types:
1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers, NPS 3/4 to NPS 20.
 2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers, NPS 3/4 to NPS 20, if longer ends are required for riser clamps.
- G. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Specification Sections, install the following types:
1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches for heavy loads.
 2. Steel Clevises (MSS Type 14): For 120 to 450 deg F piping installations.
 3. Swivel Turnbuckles (MSS Type 15): For use with MSS Type 11, split pipe rings.
 4. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.
 5. Steel Weldless Eye Nuts (MSS Type 17): For 120 to 450 deg F piping installations.

- H. Building Attachments: Unless otherwise indicated and except as specified in piping system Specification Sections, install the following types:
1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
 2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joint construction to attach to top flange of structural shape.
 3. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
 4. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
 5. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
 6. C-Clamps (MSS Type 23): For structural shapes.
 7. Top-Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge.
 8. Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.
 9. Steel-Beam Clamps with Eye Nuts (MSS Type 28): For attaching to bottom of steel I-beams for heavy loads.
 10. Linked-Steel Clamps with Eye Nuts (MSS Type 29): For attaching to bottom of steel I-beams for heavy loads, with link extensions.
 11. Malleable Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.
 12. Welded-Steel Brackets: For support of pipes from below or for suspending from above by using clip and rod. Use one of the following for indicated loads:
 - a. Light (MSS Type 31): 750 lb.
 - b. Medium (MSS Type 32): 1500 lb.
 - c. Heavy (MSS Type 33): 3000 lb.
 13. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
 14. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.
 15. Horizontal Travelers (MSS Type 58): For supporting piping systems subject to linear horizontal movement where head room is limited.
- I. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Specification Sections, install the following types:
1. Steel Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
 2. Protection Shields (MSS Type 40): Of length recommended by manufacturer to prevent crushing insulation.
 3. Thermal-Hanger Shield Inserts: For supporting insulated pipe, 360-degree insert of high-density, 100-psi minimum compressive-strength, water-repellent-treated calcium silicate or cellular-glass pipe insulation, same thickness as adjoining insulation with vapor barrier and encased in 360-degree sheet metal shield.
- J. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system Specification Sections, install the following types:
1. Restraint-Control Devices (MSS Type 47): Where indicated to control piping movement.

2. Spring Cushions (MSS Type 48): For light loads if vertical movement does not exceed 1-1/4 inches.
3. Spring-Cushion Roll Hangers (MSS Type 49): For equipping Type 41 roll hanger with springs.
4. Spring Sway Braces (MSS Type 50): To retard sway, shock, vibration, or thermal expansion in piping systems.
5. Variable-Spring Hangers (MSS Type 51): Preset to indicated load and limit variability factor to 25 percent to absorb expansion and contraction of piping system from hanger.
6. Variable-Spring Base Supports (MSS Type 52): Preset to indicated load and limit variability factor to 25 percent to absorb expansion and contraction of piping system from base support.
7. Variable-Spring Trapeze Hangers (MSS Type 53): Preset to indicated load and limit variability factor to 25 percent to absorb expansion and contraction of piping system from trapeze support.
8. Constant Supports: For critical piping stress and if necessary to avoid transfer of stress from one support to another support, critical terminal, or connected equipment. Include auxiliary stops for erection, hydrostatic test, and load-adjustment capability. These supports include the following types:
 - a. Horizontal (MSS Type 54): Mounted horizontally.
 - b. Vertical (MSS Type 55): Mounted vertically.
 - c. Trapeze (MSS Type 56): Two vertical-type supports and one trapeze member.

3.2 HANGER AND SUPPORT INSTALLATION

- A. Pipe Hanger and Support Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from building structure.
- B. Channel Support System Installation: Arrange for grouping of parallel runs of piping and support together on field-assembled channel systems.
 1. Field assemble and install according to manufacturer's written instructions.
- C. Heavy-Duty Steel Trapeze Installation: Arrange for grouping of parallel runs of horizontal piping and support together on field-fabricated, heavy-duty trapezes.
 1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified above for individual pipe hangers.
 2. Field fabricate from ASTM A 36/A 36M, steel shapes selected for loads being supported. Weld steel according to AWS D-1.1.
- D. Install building attachments within concrete slabs or attach to structural steel. Space attachments within maximum piping span length indicated in MSS SP-69. Install additional attachments at concentrated loads, including valves, flanges, guides, strainers, and expansion joints, and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.

- E. Install powder-actuated drive-pin fasteners in concrete after concrete is placed and completely cured. Use operators that are licensed by powder-actuated tool manufacturer. Install fasteners according to powder-actuated tool manufacturer's operating manual.
- F. Install mechanical-anchor fasteners in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.
- G. Install hangers and supports complete with necessary inserts, bolts, rods, nuts, washers, and other accessories.
- H. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.
- I. All piping shall be adequately supported and braced by means of adequate hangers, concrete piers, pipe supports, brackets, or as otherwise shown on the plan or recommended by the pipe and equipment manufacturer requirements. No pipe support shall fall on a pipe joint. Contractor shall provide unions and flexible couplers (not shown on plans) to provide adequate removal of valves and equipment.
- J. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.
- K. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and so maximum pipe deflections allowed by ASME B31.9, "Building Services Piping," is not exceeded.
- L. Insulated Piping: Comply with the following:
 - 1. Attach clamps and spacers to piping.
 - a. Piping Operating above Ambient Air Temperature: Clamp may project through insulation.
 - b. Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.
 - c. Do not exceed pipe stress limits according to ASME B31.9.
 - 2. Install MSS SP-58, Type 39 protection saddles, if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.
 - a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.
 - 3. Install MSS SP-58, Type 40 protective shields on cold piping with vapor barrier. Shields shall span arc of 180 degrees.
 - a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.
 - 4. Shield Dimensions for Pipe: Not less than the following:
 - a. NPS 1/4 to NPS 3-1/2: 12 inches long and 0.048 inch thick.
 - b. NPS 4: 12 inches long and 0.06 inch thick.
 - c. NPS 5 and NPS 6: 18 inches long and 0.06 inch thick.
 - d. NPS 8 to NPS 14: 24 inches long and 0.075 inch thick.

5. Insert Material: Length at least as long as protective shield.
6. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

3.3 EQUIPMENT SUPPORTS

- A. Fabricate structural-steel stands to suspend equipment from structure above or to support equipment above floor.
- B. Grouting: Place grout under supports for equipment and make smooth bearing surface.

3.4 METAL FABRICATION

- A. Cut, drill, and fit miscellaneous metal fabrications for heavy-duty steel trapezes and equipment supports.
- B. Fit exposed connections together to form hairline joints. Field-weld connections that cannot be shop-welded because of shipping size limitations.
- C. Field Welding: Comply with AWS D1.1 procedures for shielded metal arc welding, appearance and quality of welds, and methods used in correcting welding work.

3.5 ADJUSTING

- A. Hanger Adjustment: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.

3.6 PAINTING

- A. Touching Up: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
 1. Apply paint by brush or spray to provide a minimum dry film thickness of 2.0 mils.
- B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

END OF SECTION 220529

SECTION 220553 – IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes the following mechanical identification materials and their installation:
 1. Equipment nameplates.
 2. Equipment markers.
 3. Pipe markers.

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Samples: For color, letter style, and graphic representation required for each identification material and device.

1.4 QUALITY ASSURANCE

- A. ASME Compliance: Comply with ASME A13.1, "Scheme for the Identification of Piping Systems," for letter size, length of color field, colors, and viewing angles of identification devices for piping.

1.5 COORDINATION

- A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.
- B. Coordinate installation of identifying devices with location of access panels and doors.
- C. Install identifying devices before installing acoustical ceilings and similar concealment.

PART 2 - PRODUCTS

2.1 EQUIPMENT IDENTIFICATION DEVICES

- A. Equipment Nameplates: Metal, with data engraved or stamped, for permanent attachment on equipment.

1. Data:
 - a. Manufacturer, product name, model number, and serial number.
 - b. Capacity, operating and power characteristics, and essential data.
 - c. Labels of tested compliances.
 2. Location: Accessible and visible.
 3. Fasteners: As required to mount on equipment.
- B. Equipment Markers: Engraved, color-coded laminated plastic. Include contact-type, permanent adhesive.
1. Terminology: Match schedules as closely as possible.
 2. Data:
 - a. Name and plan number.
 - b. Equipment service.
 - c. Design capacity.
 - d. Other design parameters such as pressure drop, entering and leaving conditions, and speed.

2.2 PIPING IDENTIFICATION DEVICES

- A. Manufactured Pipe Markers, General: Preprinted, color-coded, with lettering indicating service, and showing direction of flow.
1. Colors: Comply with ASME A13.1, unless otherwise indicated.
 2. Lettering: Use piping system terms indicated and abbreviate only as necessary for each application length.
 3. Pipes with OD, Including Insulation, Less Than 6 Inches: Full-band pipe markers extending 360 degrees around pipe at each location.
 4. Pipes with OD, Including Insulation, 6 Inches and Larger: Either full-band or strip-type pipe markers at least three times letter height and of length required for label.
 5. Arrows: Integral with piping system service lettering to accommodate both directions; or as separate unit on each pipe marker to indicate direction of flow.
- B. Self-Adhesive Pipe Markers: Plastic with pressure-sensitive, permanent-type, self-adhesive back.
- C. Plastic Tape: Continuously printed, vinyl tape at least 3 mils thick with pressure-sensitive, permanent-type, self-adhesive back.
1. Width for Markers on Pipes with OD, Including Insulation, Less Than 6 Inches: 3/4 inch minimum.
 2. Width for Markers on Pipes with OD, Including Insulation, 6 Inches or Larger: 1-1/2 inches minimum.

PART 3 - EXECUTION

3.1 APPLICATIONS, GENERAL

- A. Products specified are for applications referenced in other Division 22 Sections. If more than single-type material, device, or label is specified for listed applications, selection is Installer's option.

3.2 EQUIPMENT IDENTIFICATION

- A. Install and permanently fasten equipment nameplates on each major item of mechanical equipment that does not have nameplate or has nameplate that is damaged or located where not easily visible. Locate nameplates where accessible and visible. Include nameplates for the following general categories of equipment:
 - 1. Water heaters.
 - 2. Sump pumps.
- B. Install equipment markers with permanent adhesive on or near each major item of mechanical equipment. Data required for markers may be included on signs, and markers may be omitted if both are indicated.
 - 1. Letter Size: Minimum 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
 - 2. Data: Distinguish among multiple units, indicate operational requirements, indicate safety and emergency precautions, warn of hazards and improper operations, and identify units.
 - 3. Locate markers where accessible and visible. Include markers for the following general categories of equipment:
 - a. Water heaters.
 - b. Sump pumps.

3.3 PIPING IDENTIFICATION

- A. Install manufactured pipe markers indicating service on each piping system. Install with flow indication arrows showing direction of flow.
 - 1. Pipes with OD, Including Insulation, Less Than 6 Inches: Self-adhesive pipe markers. Use color-coded, self-adhesive plastic tape, 1-1/2 inches wide, lapped at least 1-1/2 inches at both ends of pipe marker, and covering full circumference of pipe.
 - 2. Pipes with OD, Including Insulation, 6 Inches and Larger: Self-adhesive pipe markers. Use color-coded, self-adhesive plastic tape, at least 1-1/2 inches wide, lapped at least 3 inches at both ends of pipe marker, and covering full circumference of pipe.
- B. Locate pipe markers and color bands where piping is exposed in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior nonconcealed locations as follows:
 - 1. Near each valve and control device.

2. Near each branch connection, excluding short takeoffs for fixtures and terminal unit
3. Where flow pattern is not obvious, mark each pipe at branch.
4. Near penetrations through walls, floors, ceilings, and nonaccessible enclosures.
5. At access doors, manholes, and similar access points that permit view of concealed piping.
6. Near major equipment items and other points of origination and termination.
7. Spaced at maximum intervals of 50 feet along each run. Reduce intervals to 25 feet in areas of congested piping and equipment.
8. On piping above removable acoustical ceilings. Omit intermediately spaced markers.

3.4 ADJUSTING

- A. Relocate mechanical identification materials and devices that have become visually blocked by other work.

3.5 CLEANING

- A. Clean faces of mechanical identification devices.

END OF SECTION 220553

SECTION 220719 – PLUMBING PIPING INSULATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes preformed, rigid pipe insulation; insulating cements; field-applied jackets; accessories and attachments; and sealing compounds.
- B. This Section includes requirements for plumbing piping systems.
- C. Related Sections include the following:
 - 1. Division 7 Section "Firestopping" for firestopping materials and requirements for penetrations through fire and smoke barriers.
 - 2. Division 22 Section "Hangers and Supports" for pipe insulation shields and protection saddles.

1.3 SUBMITTALS

- A. Product Data: Identify thermal conductivity, thickness, and jackets (both factory and field applied, if any), for each type of product indicated.
- B. Installer Certificates: Signed by the Contractor certifying that installers comply with requirements.

1.4 QUALITY ASSURANCE

- A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the U.S. Department of Labor, Bureau of Apprenticeship and Training.
- B. Fire-Test-Response Characteristics: As determined by testing materials identical to those specified in this Section according to ASTM E 84, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and sealer and cement material containers with appropriate markings of applicable testing and inspecting agency.
 - 1. Insulation Installed Indoors: Flame-spread rating of 25 or less, and smoke-developed rating of 50 or less.
 - 2. Insulation Installed Outdoors: Flame-spread rating of 75 or less, and smoke-developed rating of 150 or less.

1.5 COORDINATION

- A. Coordinate size and location of supports, hangers, and insulation shields specified in Division 22 Section "Hangers and Supports."
- B. Coordinate clearance requirements with piping Installer for insulation application.

1.6 SCHEDULING

- A. Schedule insulation application after testing piping systems. Insulation application may begin on segments of piping that have satisfactory test results.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.
 - 1. Mineral-Fiber Insulation:
 - a. Johns Manville Corp.
 - b. Knauf FiberGlass GmbH.
 - c. Owens-Corning Fiberglas Corp.

2.2 INSULATION MATERIALS

- A. Mineral-Fiber Insulation: Glass fibers bonded with a thermosetting resin complying with the following:
 - 1. Preformed Pipe Insulation: Comply with ASTM C 547, Type 1, with factory-applied, all-purpose, vapor-retarder jacket.
 - 2. Fire-Resistant Adhesive: Comply with MIL-A-3316C in the following classes and grades:
 - a. Class 1, Grade A for bonding glass cloth and tape to unfaced glass-fiber insulation, for sealing edges of glass-fiber insulation, and for bonding lagging cloth to unfaced glass-fiber insulation.
 - b. Class 2, Grade A for bonding glass-fiber insulation to metal surfaces.
 - 3. Vapor-Retarder Mastics: Fire- and water-resistant, vapor-retarder mastic for indoor applications. Comply with MIL-C-19565C, Type II.
 - 4. Mineral-Fiber Insulating Cements: Comply with ASTM C 195.
 - 5. Expanded or Exfoliated Vermiculite Insulating Cements: Comply with ASTM C 196.
 - 6. Mineral-Fiber, Hydraulic-Setting Insulating and Finishing Cement: Comply with ASTM C 449/C 449M.

2.3 FIELD-APPLIED JACKETS

- A. General: ASTM C 921, Type 1, unless otherwise indicated.
- B. Standard PVC Fitting Covers: Factory-fabricated fitting covers manufactured from 20-mil- thick, high-impact, ultraviolet-resistant PVC.

1. Shapes: 45- and 90-degree, short- and long-radius elbows, tees, valves, flanges, reducers, end caps, soil-pipe hubs, traps, mechanical joints, and P-trap and supply covers for lavatories for the disabled.
 2. Adhesive: As recommended by insulation material manufacturer.
- C. Aluminum Jacket: Comply with ASTM B209, alloy 3003 or 3105. Thickness to be 0.024 inches, corrugated (cross-crimped).

2.4 VAPOR RETARDERS

- A. Mastics: Materials recommended by insulation material manufacturer that are compatible with insulation materials, jackets, and substrates.

2.5 PAINTING

- A. See Division 09.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions for compliance with requirements for installation and other conditions affecting performance of insulation application.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Surface Preparation: Clean and dry pipe and fitting surfaces. Remove materials that will adversely affect insulation application.

3.3 GENERAL APPLICATION REQUIREMENTS

- A. Apply insulation materials, accessories, and finishes according to the manufacturer's written instructions; with smooth, straight, and even surfaces; free of voids throughout the length of piping, including fittings, valves, and specialties.
- B. Refer to schedules at the end of this Section for materials, forms, jackets, and thicknesses required for each piping system.
- C. Use accessories compatible with insulation materials and suitable for the service. Use accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.
- D. Apply insulation with longitudinal seams at top and bottom of horizontal pipe runs.
- E. Seal joints and seams with vapor-retarder mastic on insulation indicated to receive a vapor retarder.

- F. Apply insulation over fittings, valves, and specialties, with continuous thermal and vapor-retarder integrity, unless otherwise indicated. Refer to special instructions for applying insulation over fittings, valves, and specialties.
- G. Apply insulation with integral jackets as follows:
 - 1. Pull jacket tight and smooth.
 - 2. Circumferential Joints: Cover with 3-inch- wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip and spaced 4 inches o.c.
 - 3. Longitudinal Seams: Overlap jacket seams at least 1-1/2 inches. Apply insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap.
 - 4. Vapor-Retarder Mastics: Where vapor retarders are indicated, apply mastic on seams and joints and at ends adjacent to flanges, unions, valves, and fittings.
 - 5. At penetrations in jackets for thermometers and pressure gages, fill and seal voids with vapor-retarder mastic.
- H. Roof Penetrations: Apply insulation for interior applications to a point even with top of roof flashing.
 - 1. Seal penetrations with vapor-retarder mastic.
 - 2. Apply insulation for exterior applications tightly joined to interior insulation ends.
 - 3. Extend metal jacket of exterior insulation outside roof flashing at least 2 inches below top of roof flashing.
 - 4. Seal metal jacket to roof flashing with vapor-retarder mastic.
- I. Exterior Wall Penetrations: For penetrations of below-grade exterior walls, terminate insulation flush with mechanical sleeve seal. Seal terminations with vapor-retarder mastic.
- J. Interior Wall and Partition Penetrations: Apply insulation continuously through walls and floors.
- K. Fire-Rated Wall and Partition Penetrations: Apply insulation continuously through penetrations of fire-rated walls and partitions.
 - 1. Firestopping and fire-resistive joint sealers are specified in Division 7 Section "Firestopping."
- L. Floor Penetrations: Apply insulation continuously through floor assembly.
 - 1. For insulation with vapor retarders, seal insulation with vapor-retarder mastic where floor supports penetrate vapor retarder.

3.4 MINERAL-FIBER INSULATION APPLICATION

- A. Apply insulation to straight pipes and tubes as follows:
 - 1. Secure each layer of preformed pipe insulation to pipe with wire, tape, or bands without deforming insulation materials.
 - 2. Where vapor retarders are indicated, seal longitudinal seams and end joints with vapor-retarder mastic. Apply vapor retarder to ends of insulation at intervals of 15 to 20 feet to form a vapor retarder between pipe insulation segments.

3. For insulation with factory-applied jackets, secure laps with outward clinched staples at 6 inches o.c.
 4. For insulation with factory-applied jackets with vapor retarders, do not staple longitudinal tabs but secure tabs with additional adhesive as recommended by the insulation material manufacturer and seal with vapor-retarder mastic.
- B. Apply insulation to fittings and elbows as follows:
1. Apply premolded insulation sections of the same material as straight segments of pipe insulation when available. Secure according to manufacturer's written instructions.
 2. When premolded insulation elbows and fittings are not available, apply mitered sections of pipe insulation, or glass-fiber blanket insulation, to a thickness equal to adjoining pipe insulation. Secure insulation materials with wire, tape, or bands.
 3. Cover fittings with standard PVC fitting covers.
- C. Apply insulation to valves and specialties as follows:
1. Apply premolded insulation sections of the same material as straight segments of pipe insulation when available. Secure according to manufacturer's written instructions.
 2. When premolded insulation sections are not available, apply glass-fiber blanket insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation. For check valves, arrange insulation for access to stainer basket without disturbing insulation.
 3. Apply insulation to flanges as specified for flange insulation application.
 4. Use preformed standard PVC fitting covers for valve sizes where available. Secure fitting covers with manufacturer's attachments and accessories. Seal seams with tape and vapor-retarder mastic.
 5. Use preformed heavy PVC fitting covers for valve sizes where available. Secure fitting covers with manufacturer's attachments and accessories. Seal seams with tape and vapor-retarder mastic.
 6. For larger sizes where PVC fitting covers are not available, seal insulation with canvas jacket and sealing compound recommended by the insulation material manufacturer.

3.5 FINISHES

- A. See Division 09.

3.6 PIPING SYSTEM APPLICATIONS

- A. Insulation materials and thicknesses are specified in schedules at the end of this Section.
- B. Items Not Insulated: Unless otherwise indicated, do not apply insulation to the following systems, materials, and equipment:
1. Flexible connectors.
 2. Vibration-control devices.
 3. Fire-suppression piping.
 4. Drainage piping located in crawl spaces, unless otherwise indicated.
 5. Below-grade piping, unless otherwise indicated.

6. Chrome-plated pipes and fittings, unless potential for personnel injury.
7. Air chambers, unions, strainers, check valves, plug valves, and flow regulators.

3.7 INSULATION APPLICATION SCHEDULE, GENERAL

- A. Application schedules identify piping system and indicate pipe size ranges and material, thickness, and jacket requirements.

3.8 INSULATION APPLICATION SCHEDULE

- A. Service: Domestic cold water systems.
 1. Operating Temperature: 40 to 90 deg F.
 2. Insulation Material: Mineral fiber.
 3. Insulation Thickness: 1/2-inch for piping up to 1.25-inch diameter. 1-inch for piping 1.5 inch diameter and larger.
 4. Jacket: All service.
 5. Vapor Retarder Required: Yes.
 6. Finish: Painted.
- B. Service: Domestic water systems (hot, tempered water, etc.).
 1. Operating Temperature: 40 to 200 deg F.
 2. Insulation Material: Mineral fiber.
 3. Insulation Thickness: 1-inch for piping up to 3/4-inch diameter. 1.25-inch for piping 1-inch and larger. Provide larger thicknesses as recommended by electric heat trace manufacturer where required.
 4. Jacket: All service.
 5. Vapor Retarder Required: Yes.
 6. Finish: Painted.
- C. Service: Exposed sanitary drains and domestic water supplies and stops for fixtures for the disabled.
 1. See "Plumbing Fixture Schedules" on the plans.

END OF SECTION 220719

SECTION 221116 - DOMESTIC WATER PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes potable domestic water piping from locations indicated to fixtures and equipment inside the building. This Section also includes non-potable water piping systems served from potable domestic water piping.
- B. Related Sections include the following:
 - 1. Division 22 Section "Meters and Gages" for thermometers, pressure gages, and fittings.
 - 2. Division 22 Section "Plumbing Specialties" for water distribution piping specialties.
 - 3. Division 40 Section "Process Pipe and Pipe Fittings" for water service piping.

1.3 PERFORMANCE REQUIREMENTS

- A. Provide components and installation capable of producing domestic water piping systems with the following minimum working-pressure ratings, unless otherwise indicated:
 - 1. Potable Domestic Water Service Piping: 175 psig.
 - 2. Potable Domestic Water Distribution Piping: 125 psig.

1.4 SUBMITTALS

- A. Product Data: For pipe, tube, fittings, and couplings.
- B. Water Samples: Specified in "Cleaning" Article in Part 3.
- C. Field Test Reports: Indicate and interpret test results for compliance with performance requirements.

1.5 QUALITY ASSURANCE

- A. Piping materials shall bear label, stamp, or other markings of specified testing agency.
- B. Comply with NSF 61, "Drinking Water System Components-Health Effects; Sections 1 through 9," for potable domestic water piping and components.

PART 2 - PRODUCTS

2.1 PIPING MATERIALS

- A. Refer to Part 3 "Piping Applications" Article for applications of pipe, tube, fitting, and joining materials.
- B. Transition Couplings for Aboveground Pressure Piping: Coupling or other manufactured fitting the same size as, with pressure rating at least equal to and ends compatible with, piping to be joined.
- C. Transition Couplings for Underground Pressure Piping: AWWA C219, metal, sleeve-type coupling or other manufactured fitting the same size as, with pressure rating at least equal to and ends compatible with, piping to be joined.

2.2 COPPER TUBING

- A. Soft Copper Tube: ASTM B 88, Types K, water tube, annealed temper.
- B. Hard Copper Tube: ASTM B 88, Types L, water tube, drawn temper.
 - 1. Copper Pressure Fittings: ASME B16.18, cast-copper-alloy or ASME B16.22, wrought-copper, solder-joint or crimped fittings. Furnish wrought-copper fittings if indicated.
 - 2. Bronze Flanges: ASME B16.24, Class 150, with solder-joint or crimped ends. Furnish Class 300 flanges if required to match piping.
 - 3. Copper Unions: MSS SP-123, cast-copper-alloy, hexagonal-stock body, with ball-and-socket, metal-to-metal seating surfaces and solder-joint, crimped, or threaded ends.
 - 4. Copper, Grooved-End Fittings: ASTM B 75 copper tube or ASTM B 584 bronze castings.

2.3 PVC PIPE AND FITTINGS

- A. PVC, Schedule 40 Pipe: ASTM D1785.
 - 1. PVC, Schedule 40 Socket Fittings: ASTM D2466.

2.4 VALVES

- A. Refer to Division 22 Section "Valves" for bronze and cast-iron, general-duty valves.
- B. Refer to Division 22 Section "Plumbing Specialties" for balancing and drain valves.

PART 3 - EXECUTION

3.1 EXCAVATION

- A. Refer to Division 31 Section "Earthwork" for excavating, trenching, and backfilling.

3.2 PIPING APPLICATIONS

- A. Transition and special fittings with pressure ratings at least equal to piping rating may be used in applications below, unless otherwise indicated.
- B. Fitting Option: Crimped joints may be used on aboveground copper tubing.
- C. Underground Potable Domestic Water Service Piping: Use the following piping materials for each size range:
 - 1. NPS 2 and Smaller: Soft copper tube, Type K, with flared fittings.
 - 2. NPS 3 and Larger: Use pipe and fittings as specified in Div. 33 Utilities.
- D. Aboveground Potable Domestic Water Piping: Use the following piping materials for each size range:
 - 1. NPS 2 and smaller: Hard copper tube, Type L; copper pressure fittings; and soldered or crimped joints.
 - 2. NPS 3 and Larger: Use pipe and fittings as specified in Div. 40 Process.
- E. Aboveground Non-Potable Water Piping: Use the following piping materials for all sizes:
 - 1. PVC, Schedule 40 pipe; PVC Schedule 40 socket fittings; and solvent-cemented joints.

3.3 VALVE APPLICATIONS

- A. Drawings indicate valve types to be used. Where specific valve types are not indicated, the following requirements apply:
 - 1. Shutoff Duty: Use bronze ball for piping NPS 3 and smaller.
 - 2. Drain Duty: Hose-end drain valves.

3.4 PIPING INSTALLATION

- A. Refer to Division 33 Sections for site water distribution and service piping.
- B. Refer to Division 22 Section "Basic Plumbing Materials and Methods" for basic piping installation.
- C. Extend domestic water service piping to exterior water distribution piping in sizes and locations indicated.
- D. Install underground copper tubing according to CDA's "Copper Tube Handbook."
- E. Install cast-iron sleeve with water stop and mechanical sleeve seal at each service pipe penetration through foundation wall. Select number of interlocking rubber links required to make installation watertight. Refer to Division 22 Section "Basic Plumbing Materials and Methods" for sleeves and mechanical sleeve seals.
- F. Install shutoff valve, hose-end drain valve, pressure gage, and test tee with valve, inside building at each domestic water service. Refer to Division 22 Section "Meters and

Gages" for pressure gages, and to Division 22 Section "Plumbing Specialties" for drain valves and strainers.

- G. Install aboveground domestic water piping level.
- H. Fill water piping. Check components to determine that they are not air bound and that piping is full of water.
- I. Check plumbing equipment and verify proper settings, adjustments, and operation. Do not operate water heaters before filling with water.
- J. Check plumbing specialties and verify proper settings, adjustments, and operation.
 - 1. Water-Pressure Regulators: Set outlet pressure at 80 psig maximum, unless otherwise indicated.

3.5 JOINT CONSTRUCTION

- A. Refer to Division 22 Section "Basic Plumbing Materials and Methods" for basic piping joint construction.
- B. Soldered Joints: Use ASTM B 813, water-flushable, lead-free flux; ASTM B 32, lead-free-alloy solder; and ASTM B 828 procedure, unless otherwise indicated.
- C. PVC Pressure Piping: Join ASTM D1785 schedule 40, PVC pipe and PVC socket fittings according to ASTM D2672.

3.6 VALVE INSTALLATION

- A. Install sectional valve close to water main on each branch and riser serving plumbing fixtures or equipment.
- B. Install shutoff valve on each water supply to equipment and on each water supply to plumbing fixtures without supply stops.
- C. Install drain valves for equipment, at base of each water riser, at low points in horizontal piping, and where required to drain water piping.
 - 1. Install hose-end drain valves at low points in water mains, risers, and branches.

3.7 HANGER AND SUPPORT INSTALLATION

- A. Refer to Division 22 Section "Hangers and Supports" for pipe hanger and support devices. Install the following:
 - 1. Vertical Piping: MSS Type 8 or Type 42, clamps.
 - 2. Individual, Straight, Horizontal Piping Runs: According to the following:
 - a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.
 - b. Longer Than 100 Feet: MSS Type 43, adjustable roller hangers.
 - c. Longer Than 100 Feet, if Indicated: MSS Type 49, spring cushion rolls.
 - 3. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
 - 4. Base of Vertical Piping: MSS Type 52, spring hangers.

- B. Install supports according to Division 22 Section "Hangers and Supports."
- C. Support vertical piping and tubing at base and at each floor.
- D. Rod diameter may be reduced 1 size for double-rod hangers, to a minimum of 3/8 inch.
- E. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:
 1. NPS 3/4 and Smaller: 60 inches with 3/8-inch rod.
 2. NPS 1 and NPS 1-1/4: 72 inches with 3/8-inch rod.
 3. NPS 1-1/2 and NPS 2: 96 inches with 3/8-inch rod.
- F. Install supports for vertical copper tubing every 10 feet.
- G. Install vinyl-coated hangers for PVC piping with the following maximum horizontal spacing and minimum rod diameters:
 1. NPS 2 and Smaller: 48 inches with 3/8-inch rod.
 2. NPS 2-1/2 to NPS 3-1/2: 48 inches with 1/2-inch rod.
 3. NPS 4 and NPS 5: 48 inches with 5/8-inch rod.
- H. Install supports for vertical PVC piping every 48 inches.
- I. Support ping and tubing not listed above according to MSS SP-69 and manufacturer's written instructions.

3.8 CONNECTIONS

- A. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to equipment and machines to allow service and maintenance.
- C. Connect domestic water piping to water service piping. Use transition fitting to join dissimilar piping materials.
- D. Connect domestic water piping to service piping with shutoff valve, and extend and connect to the following:
 1. Water Heaters: Cold-water supply and hot-water outlet piping in sizes indicated, but not smaller than sizes of water heater connections.
 2. Plumbing Fixtures: Cold- and hot-water supply piping in sizes indicated, but not smaller than required by plumbing code. Refer to Division 22 Section "Plumbing Fixtures."
 3. Equipment: Cold- and hot-water supply piping as indicated, but not smaller than equipment connections. Provide shutoff valve and union for each connection. Use flanges instead of unions for NPS 2-1/2 and larger.

3.9 FIELD QUALITY CONTROL

- A. Inspect potable domestic water piping, and non-potable water piping as follows:

1. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.
2. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction:
 - a. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.
 - b. Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.
3. Reinspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for reinspection.
4. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.

B. Test potable domestic water piping and non-potable water piping as follows:

1. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
2. Leave uncovered and unconcealed new, altered, extended, or replaced domestic water piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.
3. Cap and subject piping to static water pressure of 50 psig above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.
4. Repair leaks and defects with new materials and retest piping or portion thereof until satisfactory results are obtained.
5. Prepare reports for tests and required corrective action.

3.10 CLEANING

A. Clean and disinfect potable domestic water piping and non-potable water piping as follows:

1. Purge new piping and parts of existing domestic water piping that have been altered, extended, or repaired before using.
2. Use purging and disinfecting procedures prescribed by authorities having jurisdiction or, if methods are not prescribed, procedures described in either AWWA C651 or AWWA C652 or as described below:
 - a. Flush piping system with clean, potable water until dirty water does not appear at outlets.
 - b. Fill and isolate system according to either of the following:
 - 1) Fill system or part thereof with water/chlorine solution with at least 50 ppm of chlorine. Isolate with valves and allow to stand for 24 hours.
 - 2) Fill system or part thereof with water/chlorine solution with at least 200 ppm of chlorine. Isolate and allow to stand for three hours.
 - c. Flush system with clean, potable water until no chlorine is in water coming from system after the standing time.

- d. Submit water samples in sterile bottles to authorities having jurisdiction. Repeat procedures if biological examination shows contamination.
- B. Prepare and submit reports of purging and disinfecting activities.
- C. Clean domestic water piping systems. Remove dirt and debris as work progresses.

END OF SECTION 221116

SECTION 221316 - STORM, SANITARY WASTE AND VENT PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes soil and waste, sanitary and storm drainage and vent piping inside the building and to locations indicated.
- B. Related Sections include the following:
 - 1. Division 22 Section "Plumbing Specialties" for soil, waste, and vent piping systems specialties.

1.3 DEFINITIONS

- A. The following are industry abbreviations for plastic piping materials:
 - 1. PVC: Polyvinyl chloride plastic.
 - 2. CPVC: Chlorinated polyvinyl chloride plastic.

1.4 PERFORMANCE REQUIREMENTS

- A. Provide components and installation capable of producing piping systems with the following minimum working-pressure ratings, unless otherwise indicated:
 - 1. Soil, Waste, and Vent Piping: 10-foot head of water.
 - 2. Sanitary Sewer, Force-Main Piping: 50 psig.

1.5 SUBMITTALS

- A. Product Data: For pipe, tube, fittings, and couplings.
- B. Field Test Reports: Indicate and interpret test results for compliance with performance requirements.

1.6 QUALITY ASSURANCE

- A. Piping materials shall bear label, stamp, or other markings of specified testing agency.
- B. Comply with NSF 14, "Plastics Piping Systems Components and Related Materials," for plastic piping components. Include marking with "NSF-dwv" for plastic drain, waste, and vent piping; "NSF-drain" for plastic drain piping; "NSF-tubular" for plastic continuous waste piping; and "NSF-sewer" for plastic sewer piping.

PART 2 - PRODUCTS

2.1 PIPING MATERIALS

- A. Refer to Part 3 "Piping Applications" Article for applications of pipe, tube, fitting, and joining materials.
- B. Flexible Transition Couplings for Underground Nonpressure Piping: ASTM C 1173 with elastomeric sleeve. Include ends of same sizes as piping to be joined and include corrosion-resistant metal band on each end.
- C. Transition Couplings for Underground Pressure Piping: AWWA C219 metal, sleeve-type coupling or other manufactured fitting same size as, with pressure rating at least equal to and ends compatible with, piping to be joined.

2.2 CAST-IRON SOIL PIPING

- A. Hubless Pipe and Fittings: ASTM A 888 or CISPI 301.
 - 1. Couplings: ASTM C 1277 assembly of metal housing, corrosion-resistant fasteners, and ASTM C 564 rubber sleeve with integral, center pipe stop.
 - a. Heavy-Duty, Type 304, Stainless-Steel Couplings: ASTM A 666, Type 304, stainless-steel shield; stainless-steel bands; and sleeve.
 - 1) NPS 1-1/2 to NPS 4: 3-inch- wide shield with 4 bands.

2.3 PVC PIPING

- A. Solid Wall PVC Pipe: ASTM D2665, Drain , Waste and Vent.
 - 1. PVC Socket Fittings: ASTM D 2665, socket type, made to ASTM D 3311, drain, waste, and vent patterns and to fit pipe.

2.4 CPVC PIPING

- A. Solid Wall CPVC Pipe: Type IV, Grade I, ASTM Cell Class 23447.
 - 1. CPVC Pipe and Socket Fittings: ASTM F 2618, socket type, made to drain, waste, and vent patterns and to fit pipe.
 - 2. Manufacturer's: ChemDrain, as manufactured by Charlotte Pipe and Foundry Company, or approved equivalent.

PART 3 - EXECUTION

3.1 EXCAVATION

- A. Refer to Division 31 Section "Earthwork" for excavating, trenching, and backfilling.

3.2 PIPING APPLICATIONS

- A. Transition and special fittings with pressure ratings at least equal to piping pressure ratings may be used in applications below, unless otherwise indicated.

- B. Aboveground and Underground Storm, Soil, Waste, and Vent Piping; Exposed or in Chases: Use the following piping materials for all sizes:
 - 1. Solid wall, Schedule 40, PVC pipe: ASTM D2665 DWV, PVC socket fittings and solvent-cemented joints.
- C. Aboveground Soil, Waste, and Vent Piping in Air Plenums: Use the following piping materials for all sizes:
 - 1. Hubless, cast-iron soil piping with the following:
 - a. Couplings: Heavy-duty, Type 304, stainless steel.
- D. Aboveground and Underground Laboratory Acid Waste, and Acid Vent Piping; Use the following piping materials for all sizes:
 - 1. Solid wall, Schedule 40, CPVC pipe: ASTM F2618, CPVC socket fittings and solvent-cemented joints.

3.3 PIPING INSTALLATION

- A. Refer to Division 33 Sections for Project-site sanitary and storm sewer piping.
- B. Refer to Division 22 Section "Basic Mechanical Materials and Methods" for basic piping installation.
- C. Install cleanouts at grade and extend to where building sanitary drains connect to building sanitary sewers.
- D. Install cleanout fitting with closure plug inside the building in sanitary force-main piping.
- E. Install cast-iron sleeve with water stop and mechanical sleeve seal at each service pipe penetration through foundation wall. Select number of interlocking rubber links required to make installation watertight. Refer to Division 15 Section "Basic Mechanical Materials and Methods" for sleeves and mechanical sleeve seals.
- F. Install cast-iron soil piping according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings."
- G. Make changes in direction for soil and waste drainage and vent piping using appropriate branches, bends, and long-sweep bends. Sanitary tees and short-sweep 1/4 bends may be used on vertical stacks if change in direction of flow is from horizontal to vertical. Use long-turn, double Y-branch and 1/8-bend fittings if 2 fixtures are installed back to back or side by side with common drain pipe. Straight tees, elbows, and crosses may be used on vent lines. Do not change direction of flow more than 90 degrees. Use proper size of standard increasers and reducers if pipes of different sizes are connected. Reducing size of drainage piping in direction of flow is prohibited.
- H. Lay buried building drainage piping beginning at low point of each system. Install true to grades and alignment indicated, with unbroken continuity of invert. Place hub ends of piping upstream. Install required gaskets according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements. Maintain swab in piping and pull past each joint as completed.

- I. Install soil and waste drainage and vent piping at the following minimum slopes, unless otherwise indicated:
 - 1. Building Sanitary Drain: 2 percent downward in direction of flow for piping NPS 3 and smaller; 1 percent downward in direction of flow for piping NPS 4 and larger.
 - 2. Horizontal Sanitary Drainage Piping: 2 percent downward in direction of flow.
 - 3. Vent Piping: 1 percent down toward vertical fixture vent or toward vent stack.
- J. Sleeves are not required for cast-iron soil piping passing through concrete slabs-on-grade if slab is without membrane waterproofing.
- K. Install PVC soil and waste drainage and vent piping according to ASTM D 2665.
- L. Install underground PVC soil and waste drainage piping according to ASTM D 2321.
- M. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.

3.4 JOINT CONSTRUCTION

- A. Refer to Division 22 Section "Basic Mechanical Materials and Methods" for basic piping joint construction.
- B. Cast-Iron, Soil-Piping Joints: Make joints according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings."
 - 1. Gasketed Joints: Make with rubber gasket matching class of pipe and fittings.
 - 2. Hubless Joints: Make with rubber gasket and sleeve or clamp.
- C. PVC Nonpressure Piping Joints: Join piping according to ASTM D 2665.
- D. CPVC Nonpressure Piping Joints: Join piping according to ASTM D 2618.

3.5 HANGER AND SUPPORT INSTALLATION

- A. Refer to Division 22 Section "Hangers and Supports" for pipe hanger and support devices. Install the following:
 - 1. Vertical Piping: MSS Type 8 or Type 42, clamps.
 - 2. Individual, Straight, Horizontal Piping Runs: According to the following:
 - a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.
 - b. Longer Than 100 Feet: MSS Type 43, adjustable roller hangers.
 - c. Longer Than 100 Feet, if Indicated: MSS Type 49, spring cushion rolls.
 - 3. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
 - 4. Base of Vertical Piping: MSS Type 52, spring hangers.
- B. Install supports according to Division 22 Section "Hangers and Supports."
- C. Support vertical piping and tubing at base and at each floor.

- D. Rod diameter may be reduced 1 size for double-rod hangers, with 3/8-inch minimum rods.
- E. Install hangers for cast-iron soil piping with the following maximum horizontal spacing and minimum rod diameters:
 - 1. NPS 1-1/2 and NPS 2: 60 inches with 3/8-inch rod.
 - 2. NPS 3: 60 inches with 1/2-inch rod.
 - 3. NPS 4 and NPS 5: 60 inches with 5/8-inch rod.
- F. Install supports for vertical cast-iron soil piping every 15 feet.
- G. Install hangers for PVC piping with the following maximum horizontal spacing and minimum rod diameters:
 - 1. NPS 1-1/2 and NPS 2: 48 inches with 3/8-inch rod.
 - 2. NPS 3: 48 inches with 1/2-inch rod.
 - 3. NPS 4 and NPS 5: 48 inches with 5/8-inch rod.
- H. Install supports for vertical PVC piping every 48 inches.
- I. Support piping and tubing not listed above according to MSS SP-69 and manufacturer's written instructions.

3.6 CONNECTIONS

- A. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Connect storm, soil and waste piping to exterior sanitary and storm sewerage piping. Use transition fitting to join dissimilar piping materials.
- C. Connect drainage and vent piping to the following:
 - 1. Plumbing Fixtures: Connect drainage piping in sizes indicated, but not smaller than required by plumbing code. Refer to Division 22 Section "Plumbing Fixtures."
 - 2. Plumbing Fixtures and Equipment: Connect atmospheric vent piping in sizes indicated, but not smaller than required by authorities having jurisdiction.
 - 3. Plumbing Specialties: Connect drainage and vent piping in sizes indicated, but not smaller than required by plumbing code. Refer to Division 22 Section "Plumbing Specialties."
 - 4. Equipment: Connect drainage piping as indicated. Provide shutoff valve, if indicated, and union for each connection. Use flanges instead of unions for connections NPS 2-1/2 and larger.

3.7 FIELD QUALITY CONTROL

- A. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction.
 - 1. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.

2. Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.
- B. Reinspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for reinspection.
 - C. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.
 - D. Test sanitary and storm drainage and vent piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:
 1. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
 2. Leave uncovered and unconcealed new, altered, extended, or replaced drainage and vent piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.
 3. Roughing-in Plumbing Test Procedure: Test drainage and vent piping, except outside leaders, on completion of roughing-in. Close openings in piping system and fill with water to point of overflow, but not less than 10-foot head of water. From 15 minutes before inspection starts to completion of inspection, water level must not drop. Inspect joints for leaks.
 4. Finished Plumbing Test Procedure: After plumbing fixtures have been set and traps filled with water, test connections and prove they are gastight and watertight. Plug vent-stack openings on roof and building drains where they leave building. Introduce air into piping system equal to pressure of 1-inch wg. Use U-tube or manometer inserted in trap of water closet to measure this pressure. Air pressure must remain constant without introducing additional air throughout period of inspection. Inspect plumbing fixture connections for gas and water leaks.
 5. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
 6. Prepare reports for tests and required corrective action.

3.8 CLEANING

- A. Clean interior of piping. Remove dirt and debris as work progresses.
- B. Protect drains during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.
- C. Place plugs in ends of uncompleted piping at end of day and when work stops.

3.9 PROTECTION

- A. Exposed PVC Piping: Protect plumbing vents exposed to sunlight with two coats of water-based latex paint.

END OF SECTION 221316

SECTION 223350 - DOMESTIC-WATER HEATERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes the following water heaters:
 - 1. Commercial storage electric water heaters.
 - 2. Expansion tanks.

1.3 SUBMITTALS

- A. Product Data: For each type and size of water heater indicated. Include rated capacities, operating characteristics, furnished specialties, and accessories.
- B. Operation and Maintenance Data: For electric water heaters to include in emergency, operation, and maintenance manuals.
- C. Warranty: Special warranty specified in this Section.

1.4 QUALITY ASSURANCE

- A. Source Limitations: Obtain same type of water heaters through one source from a single manufacturer.
- B. Product Options: Drawings indicate size, profiles, and dimensional requirements of electric water heaters and are based on the specific system indicated. Refer to Division 1 Section "Product Requirements."
- C. Water heaters shall meet the thermal efficiency and/or standby loss requirements of the U.S. Department of Energy and current edition of ASHRAE/IES 90.1; 5.
- D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- E. ASME Compliance: Where indicated, fabricate and label commercial water heater storage tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
- F. Comply with NSF 61, "Drinking Water System Components - Health Effects; Sections 1 through 9," for all components that will be in contact with potable water.

1.5 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of electric water heaters that fail in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Structural failures including storage tank and supports.
 - b. Faulty operation of controls.
 - c. Deterioration of metals, metal finishes, and other materials beyond normal use.
 - 2. Warranty Period(s): From date of Substantial Completion: Three years for commercial water heaters.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 WATER HEATERS

- A. Description: Comply with UL 174 for storage electric water heaters. See "Plumbing Fixture Schedules" on the plans for all heater types, sizes, characteristics, etc.
 - 1. Manufacturers:
 - a. A.O. Smith Products Company.
 - b. Lochinvar Corporation.
 - c. Rheem Manufacturing Company.
 - d. State Industries.
 - 2. Storage-Tank Construction: Steel, vertical arrangement.
 - a. Tappings: ASME B1.20.1 pipe thread.
 - b. Pressure Rating: 150 psig.
 - 3. Factory-Installed Storage-Tank Appurtenances:
 - a. Drain Valve: ASSE 1005.
 - b. Insulation: Comply with ASHRAE 90.1, foam.
 - c. Jacket: Baked enamel finish.
 - d. Safety Control: High-temperature-limit cutoff device or system.
 - e. Relief Valve: ASME rated and stamped and complying with ASME PTC 25.3 for combination temperature and pressure relief valves. Include relieving capacity at least as great as heat input, and include pressure setting less than water heater working-pressure rating. Select relief valve with sensing element that extends into storage tank.

2.3 EXPANSION TANKS

- A. Description: Steel pressure-rated tank constructed with welded joints and factory-installed butyl-rubber diaphragm. Include air precharge to minimum system-operating pressure at tank.
 - 1. Manufacturers:
 - a. AMTROL Inc.
 - b. Smith, A. O.; Aqua-Air Div.
 - c. State Industries, Inc.
 - d. Taco, Inc.
 - 2. Construction:
 - a. Tappings: Factory-fabricated steel, welded to tank before testing and labeling. Include ASME B1.20.1, pipe thread.
 - b. Interior Finish: Comply with NSF 61 barrier materials for potable-water tank linings, including extending finish into and through tank fittings and outlets.
 - c. Air-Charging Valve: Factory installed.
 - 3. Capacity and Characteristics:
 - a. Working-Pressure Rating: 150 psig.
 - b. Capacity Acceptable: See plans and details.

PART 3 - EXECUTION

3.1 WATER HEATER INSTALLATION

- A. Install commercial water heaters on concrete pad, or as indicated on the plans.
- B. Install water heaters level and plumb, according to referenced standards. Maintain manufacturer's recommended clearances. Arrange units so controls and devices needing service are accessible.
- C. Extend commercial-water-heater relief-valve outlet, with drain piping same as domestic water piping in continuous downward pitch to within 6-inches of floor.
- D. Install thermometer on outlet piping of water heaters. Refer to Division 22 Section "Meters and Gages" for thermometers.
- E. Install piping-type heat traps on inlet and outlet piping of water heater storage tanks without integral or fitting-type heat traps.
- F. Fill water heaters with water.

3.2 CONNECTIONS

- A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to water heaters to allow service and maintenance. Arrange piping for easy removal of water heaters.

- C. Ground equipment according to Division 26 Section "Grounding and Bonding."
- D. Connect wiring according to Division 26 Section "Conductors and Cables."

3.3 FIELD QUALITY CONTROL

- A. Perform the following field tests and inspections:
 - 1. Leak Test: After installation, test for leaks. Repair leaks and retest until no leaks exist.
 - 2. Operational Test: After electrical circuitry has been energized, confirm proper operation.
 - 3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- B. Remove and replace water heaters that do not pass tests and inspections and retest as specified above.

3.4 DEMONSTRATION

- A. Train Owner's maintenance personnel to adjust, operate, and maintain commercial electric water heaters. Refer to Division 1 Section "Closeout Procedures".
- B. Operational Demonstration shall be per Division 1 Sections.
- C. Instruction of the Owner's Personnel shall be per Division Sections.

END OF SECTION 223350

SECTION 224000 - PLUMBING FIXTURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes plumbing fixtures and trim, faucets, other fittings, and related components.
- B. Related Sections: The following Sections contain requirements that relate to this Section:
 - 1. Division 7 Section "Joint Sealants" for sealing between fixtures and walls, floors, and counters.
 - 2. Division 22 Section "Valves" for general-duty valves used as supply stops.
 - 3. Division 22 Section "Plumbing Specialties" for backflow preventers and other specialties not specified in this Section.

1.3 DEFINITIONS

- A. Accessible: Plumbing fixture, building, facility, or portion thereof that can be approached, entered, and used by physically handicapped, disabled, and elderly people.
- B. Fitting: Device that controls flow of water into or out of plumbing fixture. Fittings specified in this Section include supplies and stops, faucets and spouts, shower heads and tub spouts, drains and tailpieces, traps and waste pipes. Pipe fittings, tube fittings, and general-duty valves are included where indicated.

1.4 SUBMITTALS

- A. General: Submit each item in this Article according to the Conditions of the Contract and Division 1 Specification Sections.
- B. Product Data for each plumbing fixture category and type specified. Include selected fixture, trim, fittings, accessories, appliances, appurtenances, equipment, and supports. Indicate materials and finishes, dimensions, construction details, and flow-control rates.
- C. Wiring diagrams from manufacturer for electrically operated units.
- D. Maintenance data for plumbing fixtures and components to include in the operation and maintenance manuals specified in Division 1.

1.5 QUALITY ASSURANCE

- A. Source Limitations: Obtain plumbing fixtures, faucets, and other components of each category from one source and by a single manufacturer.
 - 1. Exception: Where fixtures, faucets, or other components are not available from a single manufacturer, obtain similar products from other manufacturers specified for this category.
- B. Regulatory Requirements: Comply with requirements of CABO A117.1, "Accessible and Usable Buildings and Facilities"; Public Law 90-480, "Architectural Barriers Act"; and Public Law 101-336, "Americans with Disabilities Act"; regarding plumbing fixtures for physically handicapped people.
- C. Listing and Labeling: Provide electrically operated fixtures and components specified in this Section that are listed and labeled.
 - 1. The Terms "Listed" and "Labeled": As defined in the National Electrical Code, Article 100.
 - 2. Listing and Labeling Agency Qualifications: A "Nationally Recognized Testing Laboratory" (NRTL) as defined in OSHA Regulation 1910.7.
- D. Select combinations of fixtures and trim, faucets, fittings, and other components that are compatible.
- E. Product Options: Drawings indicate size, profiles, dimensional requirements, and characteristics of plumbing fixtures and are based on specific types and models indicated. Other manufacturers' fixtures with equal performance characteristics may be considered. Refer to Division 1 Section "Substitutions."

1.6 PROJECT CONDITIONS

- A. Field Measurements: Coordinate roughing-in and final fixture locations and verify that plumbing fixtures can be installed to comply with original design and referenced standards.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Lavatories, Urinals, Water Closets:
 - a. American Standard
 - b. Crane
 - c. Eljer
 - d. Kohler
 - 2. Mop Basins:
 - a. Fiat
 - b. Mustee
 - c. Stern-Williams
 - 3. Emergency Fixtures:
 - a. Haws
 - b. Bradley

c. Guardian

2.2 PLUMBING FIXTURE STANDARDS

- A. Comply with applicable standards below and other requirements specified.
1. National Sanitation Foundation Construction: NSF 2.
 2. Vitreous-China Fixtures: ASME A112.19.2M.
 3. Water-Closet, Flush Valve: ASME A112.19.5.

2.3 LAVATORY/SINK FAUCET STANDARDS

- A. Comply with ASME A112.18.1M and other requirements specified for lavatory, sink, and similar-type-fixture faucet fittings. Include hot- and cold-water indicators; 2.2-gpm-maximum flow rate; and polished, chrome-plated finish; except where otherwise indicated. Coordinate faucet inlets with supplies and fixture holes and outlet with spout and fixture receptor.
1. Diverter Valves for Faucets with Hose Spray: ASSE 1025.
 2. Faucet Hose: ASTM D 3901.
 3. Hose-Connection Vacuum Breakers: ASSE 1011.
 4. Hose-Coupling Threads: ASME B1.20.7.
 5. Integral, Atmospheric Vacuum Breakers: ASSE 1001.
 6. Pipe Threads: ASME B1.20.1.
 7. Sensor-Actuated Faucets and Electrical Devices: UL 1951.
 8. Sink Spray Hoses: ASTM D 3573.

2.4 MISCELLANEOUS FITTING STANDARDS

- A. Comply with ASME A112.18.1M and other requirements specified for fittings, other than faucets. Include polished, chrome-plated finish, except where otherwise indicated. Coordinate fittings with other components and connectors.
1. Atmospheric Vacuum Breakers: ASSE 1001.
 2. Automatic Flow Restrictors: ASSE 1028.
 3. Brass and Copper, Supplies and Tubular Brass: ASME A112.18.1M.
 4. Fixed Flow Restrictors: ASSE 1034.
 5. Manual-Operation Flushometers: ASSE 1037.
 6. Plastic Tubular Fittings: ASTM F 409.

2.5 MISCELLANEOUS COMPONENT STANDARDS

- A. Comply with applicable standards below and other requirements specified for components for plumbing fixtures, equipment, and appliances.
1. Floor Drains: ASME A112.21.1M.
 2. Hose-Coupling Threads: ASME B1.20.7.
 3. Pipe Threads: ASME B1.20.1.
 4. Plastic Toilet Seats: ANSI Z124.5.
 5. Supply and Drain Insulation Kits: CABO A117.1.
 6. Supports: ASME A112.6.1M.

2.6 FITTINGS

- A. Fittings for Plumbing Fixtures, unless noted otherwise: Fittings include the following:
 - 1. Supply Inlets: Brass pipe or copper tube, size required for final connection.
 - 2. Supply Stops: Chrome-plated brass, angle or straight; compression, wheel-handle type; same size as supply inlet and with outlet matching supply riser.
 - 3. Supply Risers: 1/2-inch NPS flexible copper tube with knob end. Use chrome-plated tube for exposed applications.
 - 4. Traps: Cast brass with slip-joint inlet, cleanout pipe nipple to wall, wall flange, escutcheons, and size to match equipment. Use chrome-plated tube for exposed applications.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine roughing-in for potable, hot- and cold-water supply piping systems; soil, waste, and vent piping systems; and supports. Verify that locations and sizes of piping and locations and types of supports match those indicated, before installing and connecting fixtures. Use manufacturer's roughing-in data when roughing-in data are not indicated.
- B. Examine walls, floors, and cabinets for suitable conditions where fixtures are to be installed. Do not proceed until unsatisfactory conditions have been corrected.

3.2 APPLICATIONS

- A. Include supports for plumbing fixtures according to the following:
 - 1. Carriers: For wall-hanging water closets and fixtures supported from wall construction.
 - 2. Chair Carriers: For wall-hanging urinals, lavatories, sinks, drinking fountains, and electric water coolers.
 - 3. Heavy-Duty Chair Carriers: For accessible urinals, lavatories, and other fixtures where indicated.
 - 4. Reinforcement: For floor-mounted lavatories and sinks that require securing to wall and recessed, box-mounted, electric water coolers.
 - 5. Fabricate reinforcement from 2-by-4-inch or 2-by-6-inch fire-retardant-treated-wood blocking between studs or 1/4-by-6-inch steel plates attached to studs, in wall construction, to secure fixtures to wall. Include length that will extend beyond ends of fixture mounting bracket and attach to at least 2 studs.
- B. Include fitting insulation kits for accessible fixtures according to the following:
 - 1. Lavatories: Cover hot- and cold-water supplies, stops and handles, drain, trap, and waste to wall.

3.3 PLUMBING FIXTURE INSTALLATION

- A. Assemble plumbing fixtures and trim, fittings, faucets, and other components according to manufacturers' written instructions.

- B. Install fixtures level and plumb according to manufacturers' written instructions, roughing-in drawings, and referenced standards.
- C. Install floor-mounted, floor-outlet water closets with closet flanges and gasket seals.
- D. Install wall-hanging, back-outlet water closets with support manufacturer's tiling frame or setting gage.
- E. Install toilet seats on water closets.
- F. Install wall-hanging, back-outlet urinals with gasket seals.
- G. Install flushometer valves for accessible water closets and urinals with handle mounted on wide side of compartment. Install other actuators in locations that are easy for handicapped people to reach.
- H. Fasten wall-hanging plumbing fixtures securely to supports attached to building substrate when supports are specified, and to building wall construction where no support is indicated.
- I. Fasten floor-mounted fixtures to substrate. Fasten fixtures having holes for securing fixture to wall construction, to reinforcement built into walls.
- J. Fasten recessed, wall-mounted fittings to reinforcement built into walls.
- K. Fasten wall-mounted fittings to reinforcement built into walls.
- L. Fasten counter-mounting plumbing fixtures to casework.
- M. Secure supplies to supports or substrate within pipe space behind fixture.
- N. Set mop basins in leveling bed of cement grout.
- O. Install individual stop valve in each water supply to fixture. Use gate or ball valve where specific stop valve is not specified.
- P. Install water-supply stop valves in accessible locations.
- Q. Install supply, flow-control fittings with specified flow rates in fixture supplies at stop valves.
- R. Install faucet, flow-control fittings with specified flow rates and patterns in faucet spouts when faucets are not available with required rates and patterns. Include adapters when required.
- S. Install traps on fixture outlets. Omit traps on fixtures having integral traps. Omit traps on indirect wastes, except where otherwise indicated.
- T. Install escutcheons at wall, floor, and ceiling penetrations in exposed, finished locations and within cabinets and millwork. Use deep-pattern escutcheons where required to conceal protruding pipe fittings.

- U. Seal joints between fixtures and walls, floors, and counters using sanitary-type, 1-part, mildew-resistant, silicone sealant according to sealing requirements specified in Division 7 Section "Joint Sealants." Match sealant color to fixture color.

3.4 CONNECTIONS

- A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties. The following are specific connection requirements:
 - 1. Install piping connections between plumbing fixtures and piping systems and plumbing equipment specified in other Division 22 Sections.
- B. Supply and Waste Connections to Plumbing Fixtures: Refer to plumbing fixture schedules at the end of this Section for fitting sizes and connection requirements for each plumbing fixture.
- C. Supply and Waste Connections to Equipment Specified in Other Sections: Connect equipment with supply inlets, supply stops, supply risers, and traps specified in this Section. Use fitting sizes required to match connected equipment. Connect fittings to plumbing piping.
- D. Ground equipment.
 - 1. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. Where manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.
- E. Arrange for electric-power connections to fixtures and devices that require power. Electric power is specified in Division 26 Sections.

3.5 FIELD QUALITY CONTROL

- A. Check that fixtures are complete with trim, faucets, fittings, and other specified components.
- B. Inspect installed fixtures for damage. Replace damaged fixtures and components.
- C. Test installed fixtures after water systems are pressurized and demonstrate proper operation. Replace malfunctioning fixtures and components, then retest. Repeat procedure until units operate properly.

3.6 ADJUSTING AND CLEANING

- A. Operate and adjust faucets and controls. Replace damaged and malfunctioning fixtures, fittings, and controls.
- B. Adjust water pressure at drinking fountains, electric water coolers, faucets, shower valves, and flushometer valves having controls, to produce proper flow and stream.

- C. Replace washers and seals of leaking and dripping faucets and stops.
- D. Clean fixtures, faucets, and other fittings with manufacturers' recommended cleaning methods and materials. Include the following:
 - 1. Remove faucet spouts and strainers, remove sediment and debris, and reinstall strainers and spouts.
 - 2. Remove sediment and debris from drains.

3.7 FIXTURE SCHEDULES

- A. See plans for "Plumbing Fixture Schedules."

END OF SECTION 224000

SECTION 224210 - PLUMBING SPECIALTIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes the following plumbing specialties:
 - 1. Backflow preventers.
 - 2. Thermostatic water mixing valves.
 - 3. Strainers.
 - 4. Key-operation hydrants.
 - 5. Drain valves.
 - 6. Miscellaneous piping specialties.
 - 7. Flashing materials.
 - 8. Cleanouts.
 - 9. Floor drains and roof drains.
- B. Related Sections include the following:
 - 1. Division 22 Section "Meters and Gages" for water meters, thermometers, and pressure gages.

1.3 PERFORMANCE REQUIREMENTS

- A. Provide components and installation capable of producing piping systems with following minimum working-pressure ratings, unless otherwise indicated:
 - 1. Domestic Water Piping: 125 psig.
 - 2. Sanitary Waste and Vent Piping: 10-foot head of water.

1.4 SUBMITTALS

- A. Product Data: Include rated capacities and shipping, installed, and operating weights. Indicate materials, finishes, dimensions, required clearances, and methods of assembly of components; and piping and wiring connections for the following:
 - 1. Backflow preventers.
 - 2. Thermostatic water mixing valves.
 - 3. Hose bibs and hydrants.
 - 4. Cleanouts, floor drains, and roof drains.
- B. Field test reports.
- C. Maintenance Data: For plumbing specialties to include in maintenance manuals. Include the following:
 - 1. Backflow preventers.

2. Thermostatic water mixing valves.
3. Hose bibs and hydrants.

1.5 QUALITY ASSURANCE

- A. Product Options: Drawings indicate size, profiles, and dimensional requirements of plumbing specialties and are based on the specific system indicated. Refer to Division 1 Section "Product Requirements."
- B. Plumbing specialties shall bear label, stamp, or other markings of specified testing agency.
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- D. ASME Compliance: Comply with ASME B31.9, "Building Services Piping," for piping materials and installation.
- E. NSF Compliance:
 1. Comply with NSF 14, "Plastics Piping Components and Related Materials," for drain, waste, and vent piping components. Include marking "NSF-DWV" on plastic drain, waste, and vent piping.
 2. Comply with NSF 61, "Drinking Water System Components--Health Effects, Sections 1 through 9," for potable domestic water plumbing specialties.

1.6 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 1. Operating Key Handles: Furnish one key for each key-operated hose bibb and hydrant installed.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. In other Part 2 articles where subparagraph titles below introduce lists, the following requirements apply for product selection:
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 BACKFLOW PREVENTERS

- A. Manufacturers:
 1. Ames Co., Inc.
 2. CMB Industries, Inc.; Febco Backflow Preventers.

3. Conbraco Industries, Inc.
4. Mueller Co.; Hersey Meters Div.
5. Sparco, Inc.
6. Watts Industries, Inc.; Water Products Div.
7. Zurn Industries, Inc.; Wilkins Div.

B. General: ASSE standard, backflow preventers.

1. NPS 2 and Smaller: Bronze body with threaded ends.

C. Hose-Connection Vacuum Breakers: ASSE 1011, nickel plated, with nonremovable and manual drain features, and ASME B1.20.7, garden-hose threads on outlet. Units attached to rough-bronze-finish hose connections may be rough bronze.

D. Reduced-Pressure-Principle Backflow Preventers: ASSE 1013, suitable for continuous pressure application. Include ball valve on inlet and outlet; test cocks; and pressure-differential relief valve with ASME A112.1.2 air-gap fitting located between two positive-seating check valves.

1. Pressure Loss: 12 psig maximum, through middle 1/3 of flow range.

2.3 THERMOSTATIC WATER MIXING VALVES

A. Manufacturers:

1. Lawler Manufacturing Company, Inc.
2. Leonard Valve Company.
3. Mark Controls Corp.; Powers Process Controls.
4. Symmons Industries, Inc.
5. T & S Brass and Bronze Works, Inc.

B. General: ASSE 1017, manually adjustable, thermostatic water mixing valve with bronze body, rough bronze finish. Include check stop and union on hot- and cold-water-supply inlets, adjustable temperature setting, and thermometer on outlet.

1. Type: Liquid-filled motor, operation and pressure rating 100 psig minimum.

C. Emergency Equipment: ASSE 1071, thermostatic mixing valve to supply tepid water to emergency fixtures with cold water bypass, brass with internal check stops, paraffin filled thermostatic mixing element, and temperature gauge.

D. Lavatory Sink: ASSE 1070, adjustable temperature thermostatic mixing valve with integral checks, lead-free, cast copper silicon alloy body, advanced paraffin-based thermal actuator.

2.4 STRAINERS

A. Strainers: Y-pattern, unless otherwise indicated, and full size of connecting piping. Include ASTM A 666, Type 304, stainless-steel screens with 3/64-inch round perforations, unless otherwise indicated.

1. Pressure Rating: 125-psig minimum steam working pressure, unless otherwise indicated.
2. NPS 2 and Smaller: Bronze body, with female threaded ends.

3. Y-Pattern Strainers: Screwed screen retainer with centered blowdown.
 - a. Drain: Factory- or field-installed, hose-end drain valve.

2.5 KEY-OPERATION HYDRANTS

- A. Manufacturers:
 1. Josam Co.
 2. Smith, Jay R. Mfg. Co.
 3. Tyler Pipe; Wade Div.
 4. Watts Industries, Inc.; Drainage Products Div.
 5. Zurn Industries, Inc.
- B. General: ASME A112.21.3M, key-operation hydrant with pressure rating of 125 psig.
 1. Inlet: NPS 3/4 threaded or solder joint.
 2. Outlet: ASME B1.20.7, garden-hose threads.
 3. Operating Keys: One with each key-operation hydrant.
- C. Nonfreeze Exposed-Outlet Wall Hydrants: ASSE 1019, self-drainable with integral nonremovable hose-connection vacuum breaker, casing and operating rod to match wall thickness, projecting outlet, and wall clamp.
 1. Classification: Type B, for automatic draining with hose removed or with hose attached and nozzle closed.

2.6 DRAIN VALVES

- A. Hose-End Drain Valves: MSS SP-110, NPS 3/4 ball valve, rated for 400-psig minimum CWP. Include two-piece, copper-alloy body with standard port, chrome-plated brass ball, replaceable seats and seals, blowout-proof stem, and vinyl-covered steel handle.
 1. Inlet: Threaded or solder joint.
 2. Outlet: Short-threaded nipple with ASME B1.20.7, garden-hose threads and cap.

2.7 MISCELLANEOUS PIPING SPECIALTIES

- A. Hose Bibbs: Bronze body with replaceable seat disc complying with ASME A112.18.1M for compression-type faucets. Include NPS 1/2 or NPS 3/4 threaded or solder-joint inlet, of design suitable for pressure of at least 125 psig; integral, nonremovable, vacuum breaker; and garden-hose threads complying with ASME B1.20.7 on outlet.
 1. Finish: Rough bronze.
 2. Operation: Tee handle.
- B. Roof Flashing Assemblies: Manufactured assembly made of 4-lb/sq. ft., 0.0625-inch-thick, lead flashing collar and skirt extending at least 8 inches from pipe with galvanized steel boot reinforcement, and counterflashing fitting.
 1. Manufacturers:
 - a. Acorn Engineering Company; Elmdor/Stoneman Div.
- C. Stack Flashing Fittings: Counterflashing-type, cast-iron fitting, with bottom recess for terminating roof membrane, and with threaded or hub top for extending vent pipe.

2.8 FLASHING MATERIALS

- A. Lead Sheet: ASTM B 749, Type L51121, copper bearing, with the following minimum weights and thicknesses, unless otherwise indicated:
 - 1. General Use: 4-lb/sq. ft., 0.0625-inch thickness.
 - 2. Vent Pipe Flashing: 3-lb/sq. ft., 0.0469-inch thickness.
 - 3. Burning: 6-lb/sq. ft., 0.0938-inch thickness.
- B. Copper Sheet: ASTM B 152, of the following minimum weights and thicknesses, unless otherwise indicated:
 - 1. General Applications: 12 oz./sq. ft.
 - 2. Vent Pipe Flashing: 8 oz./sq. ft.
- C. Zinc-Coated Steel Sheet: ASTM A 653/A 653M, with 0.20 percent copper content and 0.04-inch minimum thickness, unless otherwise indicated. Include G90 hot-dip galvanized, mill-phosphatized finish for painting if indicated.
- D. Elastic Membrane Sheet: ASTM D 4068, flexible, chlorinated polyethylene, 40-mil minimum thickness.
- E. Fasteners: Metal compatible with material and substrate being fastened.
- F. Metal Accessories: Sheet metal strips, clamps, anchoring devices, and similar accessory units required for installation; matching or compatible with material being installed.
- G. Solder: ASTM B 32, lead-free alloy.
- H. Bituminous Coating: SSPC-Paint 12, solvent-type, bituminous mastic.

2.9 CLEANOUTS, FLOOR DRAINS, AND ROOF DRAINS

- A. Comply with ASME. See "DRAIN SCHEDULE" on plans.
 - 1. Products:
 - a. Josam Co.
 - b. Smith, Jay R. Mfg. Co.
 - c. Tyler Pipe, Wade Div.
 - d. Watts Industries, Inc., Drainage Products Div.
 - e. Zurn Industries, Inc., Specification Drainage Operation.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Refer to Division 22 Section "Basic Plumbing Materials and Methods" for piping joining materials, joint construction, and basic installation requirements.

- B. Install backflow preventers in each water supply to mechanical equipment and systems and to other equipment and water systems that may be sources of contamination. Comply with authorities having jurisdiction.
 - 1. Locate backflow preventers in same room as connected equipment or system.
 - 2. Install drain for backflow preventers with atmospheric-vent drain connection with air-gap fitting, fixed air-gap fitting, or equivalent positive pipe separation of at least two pipe diameters in drain piping and pipe to floor drain. Locate air-gap device attached to or under backflow preventer. Simple air breaks are not acceptable for this application.
 - 3. Do not install bypass piping around backflow preventers.
- C. Install strainers on supply side of each control valve.
- D. Install cleanouts in aboveground piping and building drain piping according to the following, unless otherwise indicated:
 - 1. Size same as drainage piping up to NPS 4. Use NPS 4 for larger drainage piping unless larger cleanout is indicated.
 - 2. Locate at each change in direction of piping greater than 45 degrees.
 - 3. Locate at minimum intervals of 100 feet for piping NPS 4 and for larger piping.
 - 4. Locate at base of each vertical soil and waste stack and storm conductor.
- E. Install flashing flange and clamping device with each stack and cleanout passing through floors with waterproof membrane.
- F. Install vent flashing sleeves on stacks passing through roof. Secure over stack flashing according to manufacturer's written instructions.
- G. Install floor drains at low points of surface areas to be drained. Set grates of drains flush with finished floor, unless otherwise indicated.
 - 1. Position floor drains for easy access and maintenance.
 - 2. Set floor drains below elevation of surrounding finished floor to allow floor drainage. Set with grates depressed according to the following drainage area radii:
 - a. Radius, 30 Inches or Less: Equivalent to 1 percent slope, but not less than 1/4-inch total depression.
 - 3. Install floor-drain flashing collar or flange so no leakage occurs between drain and adjoining flooring. Maintain integrity of waterproof membranes where penetrated.
 - 4. Install individual traps for floor drains connected to sanitary building drain, unless otherwise indicated.
- H. Install roof drains at low points of roof areas according to roof membrane manufacturer's written installation instructions.
 - 1. Install roof-drain flashing collar or flange so no leakage occurs between drain and adjoining roofing. Maintain integrity of waterproof membranes where penetrated.
 - 2. Position roof drains for easy access and maintenance.
- I. Install individual ball shutoff valve in each water supply to plumbing specialties. Install shutoff valves in accessible locations. Refer to Division 22 Section "Valves".

- J. Install traps on plumbing specialty drain outlets.

3.2 CONNECTIONS

- A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to equipment to allow service and maintenance.
- C. Connect plumbing specialties to piping specified in other Division 22 Sections.
- D. Ground equipment.
- E. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.
- F. Connect plumbing specialties and devices that require power according to Division 26 Sections.

3.3 FLASHING INSTALLATION

- A. Fabricate flashing from single piece unless large pans, sumps, or other drainage shapes are required. Join flashing according to the following if required:
 - 1. Lead Sheets: Burn joints of lead sheets 6-lb/sq. ft., 0.0938-inch thickness or thicker. Solder joints of lead sheets 4-lb/sq. ft., 0.0625-inch thickness or thinner.
 - 2. Copper Sheets: Solder joints of copper sheets.
- B. Install sheet flashing on pipes, sleeves, and specialties passing through or embedded in floors and roofs with waterproof membrane.
 - 1. Pipe Flashing: Sleeve type, matching pipe size, with minimum length of 10 inches, and skirt or flange extending at least 8 inches around pipe.
 - 2. Sleeve Flashing: Flat sheet, with skirt or flange extending at least 8 inches around sleeve.
 - 3. Embedded Specialty Flashing: Flat sheet, with skirt or flange extending at least 8 inches around specialty.
- C. Set flashing on floors and roofs in solid coating of bituminous cement.
- D. Secure flashing into sleeve and specialty clamping ring or device.
- E. Install flashing for piping passing through roofs with counterflashing or flashing fittings, according to Division 7 Section "Sheet Metal Flashing and Trim."
- F. Extend flashing up vent pipe passing through roofs and turn down into pipe, or secure flashing into cast-iron sleeve having calking recess.
- G. Fabricate and install flashing and pans, sumps, and other drainage shapes.

3.4 LABELING AND IDENTIFYING

- A. Equipment Nameplates and Signs: Install engraved plastic-laminate equipment nameplate or sign on or near each backflow preventer and thermostatic water mixing valve.
 - 1. Text: Distinguish among multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations, in addition to identifying unit.
 - 2. Refer to Division 22 Section "Identification for Plumbing Piping and Equipment" for nameplates and signs.

3.5 PROTECTION

- A. Protect drains during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work. Place plugs in ends of uncompleted piping at end of each day or when work stops.

3.6 DEMONSTRATION

- A. Train Owner's maintenance personnel to adjust, operate, and maintain plumbing specialties. Refer to Division 1 Section "Closeout Procedures."

END OF SECTION 224210

SECTION 230512 - BASIC HVAC MATERIALS AND METHODS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes the following:
 1. Piping materials and installation instructions common to most piping systems.
 2. Sleeves.
 3. Escutcheons.
 4. Equipment installation requirements common to equipment sections.
 5. Painting and finishing.
 6. Concrete bases.
 7. Supports and anchorages.
 8. HVAC demolition.

1.3 DEFINITIONS

- A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct shafts, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels.
- B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.
- C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.
- D. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and in duct shafts.
- E. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.

1.4 SUBMITTALS

- A. Product Data: For the following:
 1. Escutcheons.

1.5 QUALITY ASSURANCE

- A. Steel Support Welding: Qualify processes and operators according to AWS D1.1, "Structural Welding Code--Steel."
- B. Electrical Characteristics for Mechanical Equipment: Equipment of higher electrical characteristics may be furnished provided such proposed equipment is approved in writing and connecting electrical services, circuit breakers, and conduit sizes are appropriately modified. If minimum energy ratings or efficiencies are specified, equipment shall comply with requirements.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture.

1.7 COORDINATION

- A. Arrange for pipe spaces, chases, slots, and openings in building structure during progress of construction, to allow for mechanical installations.
- B. Coordinate installation of required supporting devices and set sleeves in poured-in-place concrete and other structural components as they are constructed.
- C. Coordinate requirements for access panels and doors for mechanical items requiring access that are concealed behind finished surfaces.

PART 2 - PRODUCTS

2.1 PIPE, TUBE, AND FITTINGS

- A. Refer to individual Division 23 piping Sections for pipe, tube, and fitting materials and joining methods.
- B. Pipe Threads: ASME B1.20.1 for factory-threaded pipe and pipe fittings.

2.2 JOINING MATERIALS

- A. Refer to individual Division 23 piping Sections for special joining materials not listed below.
- B. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.
 - 1. ASME B16.21, nonmetallic, flat, asbestos-free, 1/8-inch maximum thickness unless thickness or specific material is indicated.
 - a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
 - b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.
 - 2. AWWA C110, rubber, flat face, 1/8 inch thick, unless otherwise indicated; and full-face or ring type, unless otherwise indicated.

- C. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.
- D. Plastic, Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer, unless otherwise indicated.
- E. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.
- F. Brazing Filler Metals: AWS A5.8, BCuP Series, copper-phosphorus alloys for general-duty brazing, unless otherwise indicated; and AWS A5.8, BAg1, silver alloy for refrigerant piping, unless otherwise indicated.

2.3 SLEEVES

- A. Galvanized-Steel Sheet: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint.
- B. Steel Pipe: ASTM A 53, Type E, Grade B, Schedule 40, galvanized, plain ends.
- C. Cast Iron: Cast or fabricated "wall pipe" equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.

2.4 ESCUTCHEONS

- A. Description: Manufactured wall and ceiling escutcheons and floor plates, with an ID to closely fit around pipe, tube, and insulation of insulated piping and an OD that completely covers opening.
- B. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with polished chrome-plated finish.
- C. One-Piece, Cast-Brass Type: With set screw.
 - 1. Finish: Polished chrome-plated.
- D. One-Piece, Floor-Plate Type: Cast-iron floor plate.

PART 3 - EXECUTION

3.1 PIPING SYSTEMS - COMMON REQUIREMENTS

- A. Install piping according to the following requirements and Division 23 Sections specifying piping systems.
- B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.

- C. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.
- D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- F. Install piping to permit valve servicing.
- G. Install piping at indicated slopes.
- H. Install piping free of sags and bends.
- I. Install fittings for changes in direction and branch connections.
- J. Install piping to allow application of insulation.
- K. Select system components with pressure rating equal to or greater than system operating pressure.
- L. Install escutcheons for penetrations of walls, ceilings, and floors according to the following:
 - 1. New Piping:
 - a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.
 - b. Chrome-Plated Piping: One-piece, cast-brass type with polished chrome-plated finish.
 - c. Insulated Piping: One-piece, stamped-steel type with spring clips.
 - d. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, cast-brass type with polished chrome-plated finish.
 - e. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece, cast-brass type with polished chrome-plated finish.
 - f. Bare Piping in Unfinished Service Spaces: One-piece, cast-brass type with polished chrome-plated finish.
 - g. Bare Piping in Equipment Rooms: One-piece, cast-brass type.
 - h. Bare Piping at Floor Penetrations in Equipment Rooms: One-piece, floor-plate type.
- M. Install sleeves for pipes passing through concrete and masonry walls and concrete floor and roof slabs.
 - 1. Cut sleeves to length for mounting flush with both surfaces.
 - a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches above finished floor level. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.
 - 2. Install sleeves in new walls and slabs as new walls and slabs are constructed.

3. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation. Use the following sleeve materials:
 - a. Steel Pipe Sleeves: For pipes smaller than NPS 6.
 - b. Stack Sleeve Fittings: For pipes penetrating floors with membrane waterproofing. Secure flashing between clamping flanges. Install section of cast-iron soil pipe to extend sleeve to 2 inches above finished floor level. Refer to Division 7 Sections for flashing materials and installation.
 - 1) Seal space outside of sleeve fittings with grout.
 4. Except for underground wall penetrations, seal annular space between sleeve and pipe or pipe insulation, using joint sealants appropriate for size, depth, and location of joint. Refer to Division 7 Section "Joint Sealants" for materials and installation.
- N. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Refer to Division 7 Sections for materials and installation.
- O. Verify final equipment locations for roughing-in.
- P. Refer to equipment specifications in other Sections of these Specifications for roughing-in requirements.

3.2 PIPING JOINT CONSTRUCTION

- A. Join pipe and fittings according to the following requirements and Division 22 Sections specifying piping systems.
- B. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.
- C. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter, using copper-phosphorus brazing filler metal complying with AWS A5.8.
- D. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Join pipe fittings and valves as follows:
 1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
- E. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

3.3 PIPING CONNECTIONS

- A. Make connections according to the following, unless otherwise indicated:
 1. Install unions, in piping NPS 2 and smaller, adjacent to each valve and at final connection to each piece of equipment.

3.4 EQUIPMENT INSTALLATION - COMMON REQUIREMENTS

- A. Install equipment to allow maximum possible headroom unless specific mounting heights are not indicated.
- B. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated.
- C. Install mechanical equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference to other installations. Extend grease fittings to accessible locations.
- D. Install equipment to allow right of way for piping installed at required slope.

3.5 PAINTING

- A. Damage and Touchup: Repair marred and damaged factory-painted finishes with materials and procedures to match original factory finish.

3.6 CONCRETE BASES

- A. Concrete Bases: Anchor equipment to concrete base according to equipment manufacturer's written instructions and according to seismic codes at Project.
 - 1. Construct concrete bases of dimensions indicated, but not less than 4 inches larger in both directions than supported unit.
 - 2. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of the base.
 - 3. Install epoxy-coated anchor bolts for supported equipment that extend through concrete base, and anchor into structural concrete floor.
 - 4. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 - 5. Install anchor bolts to elevations required for proper attachment to supported equipment.
 - 6. Install anchor bolts according to anchor-bolt manufacturer's written instructions.
 - 7. Use concrete and reinforcement as specified in Division 3 Section "Cast-in-Place Concrete".

3.7 ERECTION OF METAL SUPPORTS AND ANCHORAGES

- A. Refer to Division 5 Section "Metal Fabrications" for structural steel.
- B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor mechanical materials and equipment.
- C. Field Welding: Comply with AWS D1.1.

3.8 HVAC DEMOLITION

- A. Refer to Sections "Cutting and Patching" and "Selective Demolition" for general demolition requirements and procedures.
- B. Disconnect, demolish, and remove piping systems, equipment, and components indicated to be removed.
 - 1. Piping to Be Removed: Remove portion of piping indicated to be removed and cap or plug remaining piping with same or compatible piping material.
 - 2. Piping to Be Abandoned in Place: Drain piping and cap or plug piping with same or compatible piping material.
 - 3. Ducts to Be Removed: Remove portion of ducts indicated to be removed and cap remaining ducts with same or compatible ductwork material.
 - 4. Ducts to Be Abandoned in Place: Cap ducts with same or compatible ductwork material.
 - 5. Equipment to Be Removed: Disconnect and cap services and remove equipment.
 - 6. Equipment to Be Removed and Reinstalled: Disconnect and cap services and remove, clean, and store equipment; when appropriate, reinstall, reconnect, and make equipment operational.
 - 7. Equipment to Be Removed and Salvaged: Disconnect and cap services and remove equipment and deliver to Owner.
- C. If pipe, insulation, or equipment to remain is damaged in appearance or is unserviceable, remove damaged or unserviceable portions and replace with new products of equal capacity and quality.

END OF SECTION 230512

SECTION 230529 - HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes hangers and supports for HVAC piping systems and equipment.
- B. Related Sections include the following:
 - 1. Division 5 Section "Metal Fabrications" for materials for attaching hangers and supports to building structure.

1.3 DEFINITIONS

- A. MSS: Manufacturers Standardization Society for the Valve and Fittings Industry.
- B. Terminology: As defined in MSS SP-90, "Guidelines on Terminology for Pipe Hangers and Supports."

1.4 PERFORMANCE REQUIREMENTS

- A. Design channel support systems for piping to support multiple pipes capable of supporting combined weight of supported systems, system contents, and test water.
- B. Design heavy-duty steel trapezes for piping to support multiple pipes capable of supporting combined weight of supported systems, system contents, and test water.

1.5 SUBMITTALS

- A. Product Data: For each type of pipe hanger, channel support system component, and thermal-hanger shield insert indicated.
- B. Shop Drawings: Signed and sealed by a qualified professional engineer for multiple piping supports and trapeze hangers. Include design calculations and indicate size and characteristics of components and fabrication details.
- C. Welding Certificates: Copies of certificates for welding procedures and operators.

1.6 QUALITY ASSURANCE

- A. Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."

- B. Engineering Responsibility: Design and preparation of Shop Drawings and calculations for each multiple pipe support and trapeze by a qualified professional engineer.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified:
 - 1. Pipe Hangers:
 - AAA Technology and Specialties Co., Inc.
 - B-Line Systems, Inc.
 - Carpenter & Patterson, Inc.
 - Empire Tool & Manufacturing Co., Inc.
 - Globe Pipe Hanger Products, Inc.
 - Grinnell Corp.
 - GS Metals Corp.
 - Michigan Hanger Co., Inc.
 - National Pipe Hanger Corp.
 - PHD Manufacturing, Inc.
 - PHS Industries, Inc.
 - Piping Technology & Products, Inc.
 - 2. Channel Support Systems:
 - B-Line Systems, Inc.
 - Grinnell Corp.; Power-Strut Unit.
 - GS Metals Corp.
 - Michigan Hanger Co., Inc.; O-Strut Div.
 - National Pipe Hanger Corp.
 - Thomas & Betts Corp.
 - Unistrut Corp.
 - Wesanco, Inc.
 - 3. Thermal-Hanger Shield Inserts:
 - Carpenter & Patterson, Inc.
 - Michigan Hanger Co., Inc.
 - PHS Industries, Inc.
 - Pipe Shields, Inc.
 - Rilco Manufacturing Co., Inc.
 - Value Engineered Products, Inc.
 - 4. Powder-Actuated Fastener Systems:
 - Gunnebo Fastening Corp.
 - Hilti, Inc.
 - ITW Ramset/Red Head.
 - Masterset Fastening Systems, Inc.

2.2 MANUFACTURED UNITS

- A. Pipe Hangers, Supports, and Components: MSS SP-58, factory-fabricated components. Refer to "Hanger and Support Applications" Article in Part 3 for where to use specific hanger and support types.
 - 1. General:
 - Interior hangers, rods, supports, etc. to be corrosion resistant, hot dipped galvanized steel.
 - Exterior hangers, rods, supports, etc. to be corrosion resistant, Type 304 or 316 stainless steel.
 - 2. All attachments to precast hollow-core concrete slabs shall comply with concrete slab manufacturer's installation instructions.
 - 3. Nonmetallic Coatings: On attachments for electrolytic protection where attachments are in direct contact with copper tubing.

- B. Channel Support Systems: MFMA-2, factory-fabricated components for field assembly.
 - 1. Coatings: Manufacturer's standard finish unless bare metal surfaces are indicated.
 - 2. Nonmetallic Coatings: On attachments for electrolytic protection where attachments are in direct contact with copper tubing.

- C. Thermal-Hanger Shield Inserts: 100-psi minimum compressive-strength insulation, encased in sheet metal shield.
 - 1. Material for Cold Piping: ASTM C 552, Type I cellular glass or water-repellent-treated, ASTM C 533, Type I calcium silicate with vapor barrier.
 - 2. Material for Cold Piping: ASTM C 552, Type I cellular glass with vapor barrier.
 - 3. Material for Cold Piping: Water-repellent-treated, ASTM C 533, Type I calcium silicate with vapor barrier.
 - 4. Material for Hot Piping: ASTM C 552, Type I cellular glass or water-repellent-treated, ASTM C 533, Type I calcium silicate.
 - 5. Material for Hot Piping: ASTM C 552, Type I cellular glass.
 - 6. Material for Hot Piping: Water-repellent-treated, ASTM C 533, Type I calcium silicate.
 - 7. For Trapeze or Clamped System: Insert and shield cover entire circumference of pipe.
 - 8. For Clevis or Band Hanger: Insert and shield cover lower 180 degrees of pipe.
 - 9. Insert Length: Extend 2 inches beyond sheet metal shield for piping operating below ambient air temperature.

2.3 MISCELLANEOUS MATERIALS

- A. Mechanical-Anchor Fasteners: Insert-type attachments with pull-out and shear capacities appropriate for supported loads and building materials where used.

- B. Structural Steel: ASTM A 36/A 36M, steel plates, shapes, and bars, black and galvanized.

- C. Grout: ASTM C 1107, Grade B, factory-mixed and -packaged, nonshrink and nonmetallic, dry, hydraulic-cement grout.
 - 1. Characteristics: Post hardening and volume adjusting; recommended for both interior and exterior applications.

2. Properties: Nonstaining, noncorrosive, and nongaseous.
3. Design Mix: 5000-psi, 28-day compressive strength.

PART 3 - EXECUTION

3.1 HANGER AND SUPPORT APPLICATIONS

- A. General: Interior hangers, rods, supports, etc. to be corrosion resistant, hot dipped galvanized steel. Exterior hangers, rods, supports, etc. to be corrosion resistant, Type 304 or 316 stainless steel.
- B. All attachments to precast hollow-core concrete slabs shall comply with concrete slab manufacturer's installation instructions.
- C. Specific hanger requirements are specified in Sections specifying equipment and systems.
- D. Comply with MSS SP-69 for pipe hanger selections and applications that are not specified in piping system Specification Sections.
- E. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Specification Sections, install the following types:
 1. Adjustable Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated stationary pipes, NPS 1/2 to NPS 30.
 2. Yoke-Type Pipe Clamps (MSS Type 2): For suspension of 120 to 450 deg F pipes, NPS 4 to NPS 16, requiring up to 4 inches of insulation.
 3. Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes, NPS 3/4 to NPS 24, requiring clamp flexibility and up to 4 inches of insulation.
 4. Steel Pipe Clamps (MSS Type 4): For suspension of cold and hot pipes, NPS 1/2 to NPS 24, if little or no insulation is required.
 5. Pipe Hangers (MSS Type 5): For suspension of pipes, NPS 1/2 to NPS 4, to allow off-center closure for hanger installation before pipe erection.
 6. Adjustable Swivel Split- or Solid-Ring Hangers (MSS Type 6): For suspension of noninsulated stationary pipes, NPS 3/4 to NPS 8.
 7. Adjustable Steel Band Hangers (MSS Type 7): For suspension of noninsulated stationary pipes, NPS 1/2 to NPS 8.
 8. Adjustable Band Hangers (MSS Type 9): For suspension of noninsulated stationary pipes, NPS 1/2 to NPS 8.
 9. Adjustable Swivel-Ring Band Hangers (MSS Type 10): For suspension of noninsulated stationary pipes, NPS 1/2 to NPS 2.
 10. Split Pipe-Ring with or without Turnbuckle-Adjustment Hangers (MSS Type 11): For suspension of noninsulated stationary pipes, NPS 3/8 to NPS 8.
 11. Extension Hinged or Two-Bolt Split Pipe Clamps (MSS Type 12): For suspension of noninsulated stationary pipes, NPS 3/8 to NPS 3.
 12. U-Bolts (MSS Type 24): For support of heavy pipe, NPS 1/2 to NPS 30.
 13. Clips (MSS Type 26): For support of insulated pipes not subject to expansion or contraction.

14. Pipe Saddle Supports (MSS Type 36): For support of pipes, NPS 4 to NPS 36, with steel pipe base stanchion support and cast-iron floor flange.
 15. Pipe Stanchion Saddles (MSS Type 37): For support of pipes, NPS 4 to NPS 36, with steel pipe base stanchion support and cast-iron floor flange and with U-bolt to retain pipe.
 16. Adjustable Pipe Saddle Supports (MSS Type 38): For stanchion-type support for pipes, NPS 2-1/2 to NPS 36, if vertical adjustment is required, with steel pipe base stanchion support and cast-iron floor flange.
 17. Single Pipe Rolls (MSS Type 41): For suspension of pipes, NPS 1 to NPS 30, from two rods if longitudinal movement caused by expansion and contraction might occur.
 18. Adjustable Roller Hangers (MSS Type 43): For suspension of pipes, NPS 2-1/2 to NPS 20, from single rod if horizontal movement caused by expansion and contraction might occur.
 19. Complete Pipe Rolls (MSS Type 44): For support of pipes, NPS 2 to NPS 42, if longitudinal movement caused by expansion and contraction might occur but vertical adjustment is not necessary.
 20. Pipe Roll and Plate Units (MSS Type 45): For support of pipes, NPS 2 to NPS 24, if small horizontal movement caused by expansion and contraction might occur and vertical adjustment is not necessary.
 21. Adjustable Pipe Roll and Base Units (MSS Type 46): For support of pipes, NPS 2 to NPS 30, if vertical and lateral adjustment during installation might be required in addition to expansion and contraction.
- F. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Specification Sections, install the following types:
1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers, NPS 3/4 to NPS 20.
 2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers, NPS 3/4 to NPS 20, if longer ends are required for riser clamps.
- G. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Specification Sections, install the following types:
1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches for heavy loads.
 2. Steel Clevises (MSS Type 14): For 120 to 450 deg F piping installations.
 3. Swivel Turnbuckles (MSS Type 15): For use with MSS Type 11, split pipe rings.
 4. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.
 5. Steel Weldless Eye Nuts (MSS Type 17): For 120 to 450 deg F piping installations.
- H. Building Attachments: Unless otherwise indicated and except as specified in piping system Specification Sections, install the following types:
1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
 2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joint construction to attach to top flange of structural shape.
 3. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.

4. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
 5. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
 6. C-Clamps (MSS Type 23): For structural shapes.
 7. Top-Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge.
 8. Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.
 9. Steel-Beam Clamps with Eye Nuts (MSS Type 28): For attaching to bottom of steel I-beams for heavy loads.
 10. Linked-Steel Clamps with Eye Nuts (MSS Type 29): For attaching to bottom of steel I-beams for heavy loads, with link extensions.
 11. Malleable Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.
 12. Welded-Steel Brackets: For support of pipes from below or for suspending from above by using clip and rod. Use one of the following for indicated loads:
 - a. Light (MSS Type 31): 750 lb.
 - b. Medium (MSS Type 32): 1500 lb.
 - c. Heavy (MSS Type 33): 3000 lb.
 13. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
 14. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.
 15. Horizontal Travelers (MSS Type 58): For supporting piping systems subject to linear horizontal movement where head room is limited.
- I. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Specification Sections, install the following types:
1. Steel Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
 2. Protection Shields (MSS Type 40): Of length recommended by manufacturer to prevent crushing insulation.
 3. Thermal-Hanger Shield Inserts: For supporting insulated pipe, 360-degree insert of high-density, 100-psi minimum compressive-strength, water-repellent-treated calcium silicate or cellular-glass pipe insulation, same thickness as adjoining insulation with vapor barrier and encased in 360-degree sheet metal shield.
- J. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system Specification Sections, install the following types:
1. Restraint-Control Devices (MSS Type 47): Where indicated to control piping movement.
 2. Spring Cushions (MSS Type 48): For light loads if vertical movement does not exceed 1-1/4 inches.
 3. Spring-Cushion Roll Hangers (MSS Type 49): For equipping Type 41 roll hanger with springs.
 4. Spring Sway Braces (MSS Type 50): To retard sway, shock, vibration, or thermal expansion in piping systems.
 5. Variable-Spring Hangers (MSS Type 51): Preset to indicated load and limit variability factor to 25 percent to absorb expansion and contraction of piping system from hanger.

6. Variable-Spring Base Supports (MSS Type 52): Preset to indicated load and limit variability factor to 25 percent to absorb expansion and contraction of piping system from base support.
7. Variable-Spring Trapeze Hangers (MSS Type 53): Preset to indicated load and limit variability factor to 25 percent to absorb expansion and contraction of piping system from trapeze support.
8. Constant Supports: For critical piping stress and if necessary to avoid transfer of stress from one support to another support, critical terminal, or connected equipment. Include auxiliary stops for erection, hydrostatic test, and load-adjustment capability. These supports include the following types:
 - a. Horizontal (MSS Type 54): Mounted horizontally.
 - b. Vertical (MSS Type 55): Mounted vertically.
 - c. Trapeze (MSS Type 56): Two vertical-type supports and one trapeze member.

3.2 HANGER AND SUPPORT INSTALLATION

- A. Pipe Hanger and Support Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from building structure.
- B. All attachments to precast hollow-core concrete slabs shall comply with concrete slab manufacturer's installation instructions.
- C. Channel Support System Installation: Arrange for grouping of parallel runs of piping and support together on field-assembled channel systems.
 1. Field assemble and install according to manufacturer's written instructions.
- D. Heavy-Duty Steel Trapeze Installation: Arrange for grouping of parallel runs of horizontal piping and support together on field-fabricated, heavy-duty trapezes.
 1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified above for individual pipe hangers.
 2. Field fabricate from ASTM A 36/A 36M, steel shapes selected for loads being supported. Weld steel according to AWS D-1.1.
- E. Install building attachments within concrete slabs or attach to structural steel. Space attachments within maximum piping span length indicated in MSS SP-69. Install additional attachments at concentrated loads, including valves, flanges, guides, strainers, and expansion joints, and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.
- F. Install mechanical-anchor fasteners in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.
- G. Install hangers and supports complete with necessary inserts, bolts, rods, nuts, washers, and other accessories.

- H. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.
- I. All piping shall be adequately supported and braced by means of adequate hangers, concrete piers, pipe supports, brackets, or as otherwise shown on the plan or recommended by the pipe and equipment manufacturer requirements. No pipe support shall fall on a pipe joint. Contactor shall provide unions and flexible couplers (not shown on plans) to provide adequate removal of valves and equipment.
- J. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.
- K. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and so maximum pipe deflections allowed by ASME B31.9, "Building Services Piping," is not exceeded.
- L. Insulated Piping: Comply with the following:
 - 1. Attach clamps and spacers to piping.
 - a. Piping Operating above Ambient Air Temperature: Clamp may project through insulation.
 - b. Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.
 - c. Do not exceed pipe stress limits according to ASME B31.9.
 - 2. Install MSS SP-58, Type 39 protection saddles, if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.
 - a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.
 - 3. Install MSS SP-58, Type 40 protective shields on cold piping with vapor barrier. Shields shall span arc of 180 degrees.
 - a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.
 - 4. Shield Dimensions for Pipe: Not less than the following:
 - a. NPS 1/4 to NPS 3-1/2: 12 inches long and 0.048 inch thick.
 - b. NPS 4: 12 inches long and 0.06 inch thick.
 - c. NPS 5 and NPS 6: 18 inches long and 0.06 inch thick.
 - d. NPS 8 to NPS 14: 24 inches long and 0.075 inch thick.
 - 5. Insert Material: Length at least as long as protective shield.
 - 6. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

3.3 EQUIPMENT SUPPORTS

- A. Fabricate structural-steel stands to suspend equipment from structure above or to support equipment above floor.

3.4 METAL FABRICATION

- A. Cut, drill, and fit miscellaneous metal fabrications for heavy-duty steel trapezes and equipment supports.
- B. Fit exposed connections together to form hairline joints. Field-weld connections that cannot be shop-welded because of shipping size limitations.
- C. Field Welding: Comply with AWS D1.1 procedures for shielded metal arc welding, appearance and quality of welds, and methods used in correcting welding work, and with the following:
 - 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
 - 2. Obtain fusion without undercut or overlap.
 - 3. Remove welding flux immediately.
 - 4. Finish welds at exposed connections so no roughness shows after finishing and contours of welded surfaces match adjacent contours.

3.5 ADJUSTING

- A. Hanger Adjustment: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.

3.6 PAINTING

- A. Touching Up: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
 - 1. Apply paint by brush or spray to provide a minimum dry film thickness of 2.0 mils.
- B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

END OF SECTION 230529

SECTION 230553 – IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes the following mechanical identification materials and their installation:
 1. Equipment nameplates.
 2. Equipment markers.
 3. Access panel and door markers.
 4. Pipe markers.

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Samples: For color, letter style, and graphic representation required for each identification material and device.

1.4 QUALITY ASSURANCE

- A. ASME Compliance: Comply with ASME A13.1, "Scheme for the Identification of Piping Systems," for letter size, length of color field, colors, and viewing angles of identification devices for piping.

1.5 COORDINATION

- A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.
- B. Coordinate installation of identifying devices with location of access panels and doors.
- C. Install identifying devices before installing acoustical ceilings and similar concealment.

PART 2 - PRODUCTS

2.1 EQUIPMENT IDENTIFICATION DEVICES

- A. Equipment Nameplates: Metal, with data engraved or stamped, for permanent attachment on equipment.

1. Data:
 - a. Manufacturer, product name, model number, and serial number.
 - b. Capacity, operating and power characteristics, and essential data.
 - c. Labels of tested compliances.
 2. Location: Accessible and visible.
 3. Fasteners: As required to mount on equipment.
- B. Equipment Markers: Engraved, color-coded laminated plastic. Include contact-type, permanent adhesive.
1. Terminology: Match schedules as closely as possible.
 2. Data:
 - a. Name and plan number.
 - b. Equipment service.
 - c. Design capacity.
 - d. Other design parameters such as pressure drop, entering and leaving conditions, and speed.
 3. Size: 2-1/2 by 4 inches for control devices, dampers, and valves; 4-1/2 by 6 inches for equipment.
- C. Access Panel and Door Markers: 1/16-inch- thick, engraved laminated plastic, with abbreviated terms and numbers corresponding to identification. Provide 1/8-inch center hole for attachment.
1. Fasteners: Self-tapping, stainless-steel screws or contact-type, permanent adhesive.

2.2 PIPING IDENTIFICATION DEVICES

- A. Manufactured Pipe Markers, General: Preprinted, color-coded, with lettering indicating service, and showing direction of flow.
1. Colors: Comply with ASME A13.1, unless otherwise indicated.
 2. Lettering: Use piping system terms indicated and abbreviate only as necessary for each application length.
 3. Pipes with OD, Including Insulation, Less Than 6 Inches: Full-band pipe markers extending 360 degrees around pipe at each location.
 4. Pipes with OD, Including Insulation, 6 Inches and Larger: Either full-band or strip-type pipe markers at least three times letter height and of length required for label.
 5. Arrows: Integral with piping system service lettering to accommodate both directions; or as separate unit on each pipe marker to indicate direction of flow.
- B. Self-Adhesive Pipe Markers: Plastic with pressure-sensitive, permanent-type, self-adhesive back.
- C. Plastic Tape: Continuously printed, vinyl tape at least 3 mils thick with pressure-sensitive, permanent-type, self-adhesive back.
1. Width for Markers on Pipes with OD, Including Insulation, Less Than 6 Inches: 3/4 inch minimum.
 2. Width for Markers on Pipes with OD, Including Insulation, 6 Inches or Larger: 1-1/2 inches minimum.

PART 3 - EXECUTION

3.1 APPLICATIONS, GENERAL

- A. Products specified are for applications referenced in other Division 23 Sections. If more than single-type material, device, or label is specified for listed applications, selection is Installer's option.

3.2 EQUIPMENT IDENTIFICATION

- A. Install and permanently fasten equipment nameplates on each major item of mechanical equipment that does not have nameplate or has nameplate that is damaged or located where not easily visible. Locate nameplates where accessible and visible. Include nameplates for the following general categories of equipment:
 - 1. Fuel-burning units, including furnaces, unit heaters, and water heaters.
 - 2. Compressors, condensers, and similar motor-driven units.
 - 3. Fans, blowers, primary balancing dampers, and mixing boxes.
 - 4. Packaged HVAC central-station and zone-type units.
- B. Install equipment markers with permanent adhesive on or near each major item of mechanical equipment. Data required for markers may be included on signs, and markers may be omitted if both are indicated.
 - 1. Letter Size: Minimum 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
 - 2. Data: Distinguish among multiple units, indicate operational requirements, indicate safety and emergency precautions, warn of hazards and improper operations, and identify units.
 - 3. Locate markers where accessible and visible. Include markers for the following general categories of equipment:
 - a. Fuel-burning units, including furnaces, unit heaters, and water heaters.
 - b. Compressors, condensers, and similar motor-driven units.
 - c. Fans, blowers, primary balancing dampers, and mixing boxes.
 - d. Packaged HVAC central-station and zone-type units.
- C. Install access panel markers with screws on equipment access panels.

3.3 PIPING IDENTIFICATION

- A. Install manufactured pipe markers indicating service on each piping system. Install with flow indication arrows showing direction of flow.
 - 1. Pipes with OD, Including Insulation, Less Than 6 Inches: Self-adhesive pipe markers. Use color-coded, self-adhesive plastic tape, 1-1/2 inches wide, lapped at least 1-1/2 inches at both ends of pipe marker, and covering full circumference of pipe.

2. Pipes with OD, Including Insulation, 6 Inches and Larger: Self-adhesive pipe markers. Use color-coded, self-adhesive plastic tape, at least 1-1/2 inches wide, lapped at least 3 inches at both ends of pipe marker, and covering full circumference of pipe.
- B. Locate pipe markers and color bands where piping is exposed in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior nonconcealed locations as follows:
1. Near each valve and control device.
 2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
 3. Near penetrations through walls, floors, ceilings, and nonaccessible enclosures.
 4. At access doors, manholes, and similar access points that permit view of concealed piping.
 5. Near major equipment items and other points of origination and termination.
 6. Spaced at maximum intervals of 50 feet along each run. Reduce intervals to 25 feet in areas of congested piping and equipment.
 7. On piping above removable acoustical ceilings. Omit intermediately spaced markers.

3.4 ADJUSTING

- A. Relocate mechanical identification materials and devices that have become visually blocked by other work.

3.5 CLEANING

- A. Clean faces of mechanical identification devices.

END OF SECTION 230553

SECTION 230593 - TESTING, ADJUSTING, AND BALANCING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes TAB to produce design objectives for the following:
 - 1. Air Systems:
 - a. Constant-volume and variable-volume air systems.
 - 2. HVAC equipment quantitative-performance settings.
 - 3. Verifying that automatic control devices are functioning properly.
 - 4. Reporting results of activities and procedures specified in this Section.

1.3 DEFINITIONS

- A. TAB: Testing, adjusting, and balancing.
- B. Testing, Adjusting, and Balancing (TAB) Firm: The entity responsible for performing and reporting TAB procedures.

1.4 SUBMITTALS

- A. Certified TAB Reports: Submit two copies of reports prepared, as specified in this Section, on approved forms certified by TAB firm.

1.5 QUALITY ASSURANCE

- A. TAB Firm Qualifications: Engage a TAB firm certified by either AABC or NEBB.

1.6 COORDINATION

- A. Coordinate the efforts of factory-authorized service representatives for systems and equipment, HVAC controls installers, and other mechanics to operate HVAC systems and equipment to support and assist TAB activities.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine the Contract Documents to become familiar with Project requirements and to discover conditions in systems' designs that may preclude proper TAB of systems and equipment.
- B. Examine approved submittal data of HVAC systems and equipment.
- C. Examine systems for functional deficiencies that cannot be corrected by adjusting and balancing.

3.2 GENERAL PROCEDURES FOR TESTING AND BALANCING

- A. Perform testing and balancing procedures on each system according to the procedures contained in AABC's "National Standards for Testing and Balancing Heating, Ventilating, and Air Conditioning Systems" or NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems", and this Section.
- B. Take and report testing and balancing measurements in inch-pound (IP) units.

3.3 GENERAL PROCEDURES FOR BALANCING AIR SYSTEMS

- A. Prepare test reports for both fans and outlets. Obtain manufacturer's outlet factors and recommended testing procedures. Crosscheck the summation of required outlet volumes with required fan volumes.

3.4 PROCEDURES FOR CONSTANT – VOLUME AIR SYSTEMS

- A. Adjust fans to deliver total indicated airflows within the maximum allowable fan speed listed by fan manufacturer.
- B. Adjust terminal outlets and inlets for each space to indicated airflows within specified tolerances of indicated values. Make adjustments using volume dampers rather than extractors and the dampers at air terminals.

3.5 PROCEDURES FOR MOTORS

- A. Motors, 1/2 HP and Larger: Test at final balanced conditions and record the following data:
 - 1. Manufacturer, model, and serial numbers.
 - 2. Motor horsepower rating.
 - 3. Motor rpm.
 - 4. Efficiency rating.
 - 5. Nameplate and measured voltage, amperage, each phase.
 - 6. Starter thermal-protection-element rating.

3.6 PROCEDURES FOR CONDENSING UNITS

- A. Verify proper rotation of fans.

- B. Measure entering and leaving air temperatures.
- C. Record compressor data.

3.7 PROCEDURES FOR TEMPERATURE MEASUREMENTS

- A. During TAB, report the need for adjustment in temperature regulation within the automatic temperature-control system.
- B. Measure indoor dry-bulb temperatures every other hour for a period of two successive eight-hour days, in each separately controlled zone, to prove correctness of final temperature settings.
- C. Measure outside-air dry-bulb temperatures.

3.8 CONTROLS VERIFICATION

- A. In conjunction with system balancing, perform the following:
 1. Verify temperature control system is operating within the design limitations.
 2. Confirm that the sequences of operation are in compliance with Contract Documents.
 3. Verify that controllers are calibrated and function as intended.
 4. Verify that controller set points are as indicated.
 5. Verify the operation of lockout or interlock systems.
 6. Verify the operation of valve and damper actuators.
 7. Verify that controlled devices are properly installed and connected to correct controller.
 8. Verify that controlled devices travel freely and are in position indicated by controller: open, closed, or modulating.
 9. Verify location and installation of sensors to ensure that they sense only intended temperature, humidity, or pressure.
- B. Reporting: Include a summary of verifications performed, remaining deficiencies, and variations from indicated conditions.

3.9 TOLERANCES

- A. Set HVAC system airflow and water flow rates within the following tolerances:
 1. Supply, Return, and Exhaust Fans and Equipment with Fans: Plus 5 to plus 10 percent.
 2. Air Outlets and Inlets: 0 to minus 10 percent.

3.10 FINAL REPORT

- A. General: Typewritten, or computer printout in letter-quality font, on standard bond paper, in three-ring binder, tabulated and divided into sections by tested and balanced systems.
- B. Include a certification sheet in front of binder signed and sealed by the certified testing and balancing engineer.

- C. Rooftop Unit Test Reports: For rooftop units, include the following:
1. Unit Data:
 - a. Unit identification.
 - b. Location.
 - c. Make and type.
 - d. Model number and unit size.
 - e. Manufacturer's serial number.
 - f. Unit arrangement and class.
 - g. Discharge arrangement.
 - h. Sheave make, size in inches, and bore.
 - i. Center-to-center dimensions of sheave and amount of adjustments in inches.
 - j. Number, make, and size of belts.
 - k. Number, type, and size of filters.
 2. Motor Data:
 - a. Motor make, and frame type and size.
 - b. Horsepower and rpm.
 - c. Volts, phase, and hertz.
 - d. Full-load amperage and service factor.
 3. Test Data (Indicated and Actual Values):
 - a. Total airflow rate in cfm.
 - b. Total system static pressure in inches wg.
 - c. Fan rpm.
 - d. Discharge static pressure in inches wg.
 - e. Filter static-pressure differential in inches wg.
 - f. Outdoor airflow in cfm.
 - g. Return airflow in cfm.
 - h. Outdoor-air damper position.
 - i. Return-air damper position.
- D. Gas-Fired Heat Apparatus Test Reports: In addition to manufacturer's factory startup equipment reports, include the following:
1. Unit Data:
 - a. System identification.
 - b. Location.
 - c. Make and type.
 - d. Model number and unit size.
 - e. Manufacturer's serial number.
 - f. Fuel type in input data.
 - g. Output capacity in Btuh.
 - h. Ignition type.
 - i. Burner-control types.
 - j. Motor horsepower and rpm.
 - k. Motor volts, phase, and hertz.
 - l. Motor full-load amperage and service factor.
 - m. Sheave make, size in inches, and bore.
 - n. Sheave dimensions, center-to-center, and amount of adjustments in inches.
 2. Test Data (Indicated and Actual Values):
 - a. Total airflow rate in cfm.
 - b. Entering-air temperature in deg F.

- c. Leaving-air temperature in deg F.
 - d. Air temperature differential in deg F.
 - e. Entering-air static pressure in inches wg.
 - f. Leaving-air static pressure in inches wg.
 - g. Air static-pressure differential in inches wg.
 - h. Low-fire fuel input in Btuh.
 - i. High-fire fuel input in Btuh.
 - j. Manifold pressure in psig.
 - k. High-temperature-limit setting in deg F.
 - l. Operating set point in Btuh.
 - m. Motor voltage at each connection.
 - n. Motor amperage for each phase.
 - o. Heating value of fuel in Btuh.
- E. Electric-Coil Test Reports: For electric furnaces, duct coils, and electric coils installed in central-station air-handling units, include the following:
- 1. Unit Data:
 - a. System identification.
 - b. Location.
 - c. Coil identification.
 - d. Capacity in kW.
 - e. Number of stages.
 - f. Connected volts, phase, and hertz.
 - g. Rated amperage.
 - h. Airflow rate in cfm.
 - i. Face area in sq. ft.
 - j. Minimum face velocity in fpm.
 - 2. Test Data (Indicated and Actual Values):
 - a. Heat output in kW and Btu/h.
 - b. Airflow rate in cfm.
 - c. Air velocity in fpm.
 - d. Entering-air temperature in deg F.
 - e. Leaving-air temperature in deg F.
 - f. Voltage at each connection.
 - g. Amperage for each phase.
- F. Fan Test Reports: For supply, return, and exhaust fans, include the following:
- 1. Fan Data:
 - a. System identification.
 - b. Location.
 - c. Make and type.
 - d. Model number and size.
 - e. Manufacturer's serial number.
 - f. Arrangement and class.
 - g. Sheave make, size in inches, and bore.

- h. Sheave dimensions, center-to-center, and amount of adjustments in inches.
 - i. Number of belts, make, and size.
 - 2. Motor Data:
 - a. Make and frame type and size.
 - b. Horsepower and rpm.
 - c. Volts, phase, and hertz.
 - d. Full-load amperage and service factor.
 - 3. Test Data (Indicated and Actual Values):
 - a. Total airflow rate in cfm.
 - b. Total system static pressure in inches wg.
 - c. Fan rpm.
 - d. Discharge static pressure in inches wg.
 - e. Suction static pressure in inches wg.
- G. Air-Terminal-Device Reports:
 - 1. Unit Data:
 - a. System and air-handling unit identification.
 - b. Location and zone.
 - c. Test apparatus used.
 - d. Area served.
 - e. Air-terminal-device make.
 - f. Air-terminal-device number from system diagram.
 - g. Air-terminal-device type and model number.
 - h. Air-terminal-device size.
 - i. Air-terminal-device effective area in sq. ft. (sq. m).
 - 2. Test Data (Indicated and Actual Values):
 - a. Airflow rate in cfm (L/s).
 - b. Air velocity in fpm (m/s).
 - c. Preliminary airflow rate as needed in cfm (L/s).
 - d. Preliminary velocity as needed in fpm (m/s).
 - e. Final airflow rate in cfm (L/s).
 - f. Final velocity in fpm (m/s).
 - g. Space temperature in deg F (deg C).

3.11 ADDITIONAL TESTS

- A. Within 90 days of completing TAB, perform additional testing and balancing to verify that balanced conditions are being maintained throughout and to correct unusual conditions.
- B. Seasonal Periods: If initial TAB procedures were not performed during near-peak summer and winter conditions, perform additional testing, inspecting, and adjusting during near-peak summer and winter conditions.

END OF SECTION 230593

SECTION 230713 - HVAC DUCT INSULATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes semi-rigid and flexible duct and plenum insulation; insulating cements; accessories and attachments; and sealing compounds.

1.3 SUBMITTALS

- A. Product Data: Identify thermal conductivity, thickness, and jackets (both factory and field applied, if any), for each type of product indicated.
- B. Installer Certificates: Signed by the Contractor certifying that installers comply with requirements.

1.4 QUALITY ASSURANCE

- A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the U.S. Department of Labor, Bureau of Apprenticeship and Training.
- B. Fire-Test-Response Characteristics: As determined by testing materials identical to those specified in this Section according to ASTM E 84, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and sealer and cement material containers with appropriate markings of applicable testing and inspecting agency.
 - 1. Insulation Installed Indoors: Flame-spread rating of 25 or less, and smoke-developed rating of 50 or less.
 - 2. Insulation Installed Outdoors: Flame-spread rating of 75 or less, and smoke-developed rating of 150 or less.

1.5 COORDINATION

- A. Coordinate clearance requirements with duct Installer for insulation application.
- B. Coordinate insulation installation with ceiling and wall installations.

1.6 SCHEDULING

- A. Schedule insulation application after testing duct systems.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Mineral-Fiber Insulation:
 - a. Johns Manville Corp.
 - b. Knauf FiberGlass GmbH.
 - c. Owens-Corning Fiberglas Corp.

2.2 INSULATION MATERIALS

- A. Mineral-Fiber Blanket Thermal Insulation: Glass fibers bonded with a thermosetting resin. Comply with ASTM C1290, Type III, density of 1.5 PCF, with factory-applied foil-scrim-kraft jacket (FSK).
- B. Mineral-Fiber Board Insulation: Glass fibers bonded with resin. ASTM C612, density 3.0 PCF, with factory applied all service jacket (ASJ).

2.3 FIELD APPLIED JACKETS

- A. Aluminum Jacket: Comply with ASTM B209, Alloy 3003, 3105. Thickness to be 0.016 inches, finish to be corrugated (cross-crimped).

2.4 ACCESSORIES

- A. Mastics: Materials recommended by insulation material manufacturer that are compatible with insulation materials, jackets, and substrates.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions for compliance with requirements for installation and other conditions affecting performance of insulation application.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

3.3 GENERAL APPLICATION REQUIREMENTS

- A. Apply insulation materials, accessories, and finishes according to the manufacturer's written instructions; with smooth, straight, and even surfaces; and free of voids throughout the length of ducts and fittings.
- B. Refer to schedules at the end of this Section for materials, forms, jackets, and thicknesses required for each duct system.
- C. Use accessories compatible with insulation materials and suitable for the service. Use accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.
- D. Interior Wall and Partition Penetrations: Apply insulation continuously through walls and partitions, except fire-rated walls and partitions.
- E. Fire-Rated Wall and Partition Penetrations: Terminate insulation at fire/smoke damper sleeves for fire-rated wall and partition penetrations.

3.4 SYSTEM PENETRATIONS

- A. Insulation Installation at Aboveground Exterior Wall Penetrations: Terminate insulation at exterior wall penetrations.
 - 1. Seal penetrations with flashing sealant.
 - 2. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
 - 3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches.
 - 4. Seal jacket to wall with flashing sealant.

3.5 APPLICATIONS

- A. Insulate the following systems:
 - 1. Indoor, outside-air ducts and plenums.
 - 2. Indoor, supply-air ducts and plenums.
 - 3. Outdoor, supply-air and return-air ducts and plenums.
- B. Items Not Insulated: Unless otherwise indicated, do not apply insulation to the following systems, materials, and equipment:
 - 1. Metal ducts with duct liner.
 - 2. Interior supply-air ductwork serving Makeup Air Units (MAU); Heating ducts are in the conditioned space.
 - 3. Exhaust ductwork serving Exhaust Fans (EF).
 - 4. Testing agency labels, equipment nameplates, or access panels/doors.

3.6 APPLICATION SCHEDULE

- A. Service: Indoor, exposed outside-air ducts and plenums, serving Makeup Air Units (MAU) and Intake Hoods (IH).
 - 1. Material: Mineral-fiber blanket, 1.5-inches thick.
- B. Service: Indoor, concealed outside-air ducts and plenums, serving Air Conditioning Units (ACU).
 - 1. Material: Mineral-fiber blanket, 1.5-inches thick.
- C. Service: Indoor, concealed supply-air and return-air ducts and plenums, serving Rooftop Units (RTU).
 - 1. Material: Mineral-fiber blanket, 1.5-inches thick.
- D. Service: Indoor, exposed supply-air ducts and plenums, serving Rooftop Units (RTU).
 - 1. Material: Mineral-fiber blanket, 1.5-inches thick.
- E. Service: Outdoor, supply-air and return-air ducts and plenums, serving Rooftop Units (RTU).
 - 1. Material: Mineral-fiber board, 3-inches thick.
 - 2. Field Applied Jacket: Aluminum, corrugated, 0.016-inches thick.
- F. Service: Outdoor, supply-air ducts and plenums, serving Makeup Air Units (MAU).
 - 1. Material: Mineral-fiber board, 3-inches thick.
 - 2. Field Applied Jacket: Aluminum, corrugated, 0.016-inches thick.

END OF SECTION 220713

SECTION 230719 - HVAC PIPING INSULATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes preformed, flexible pipe insulation; insulating cements; field-applied jackets; accessories and attachments; and sealing compounds.
- B. Related Sections include the following:
 - 1. Division 23 Section "Hangers and Supports" for pipe insulation shields and protection saddles.

1.3 SUBMITTALS

- A. Product Data: Identify thermal conductivity, thickness, and jackets (both factory and field applied, if any), for each type of product indicated.
- B. Installer Certificates: Signed by the Contractor certifying that installers comply with requirements.

1.4 QUALITY ASSURANCE

- A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the U.S. Department of Labor, Bureau of Apprenticeship and Training.
- B. Fire-Test-Response Characteristics: As determined by testing materials identical to those specified in this Section according to ASTM E 84, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and sealer and cement material containers with appropriate markings of applicable testing and inspecting agency.
 - 1. Insulation Installed Indoors: Flame-spread rating of 25 or less, and smoke-developed rating of 50 or less.
 - 2. Insulation Installed Outdoors: Flame-spread rating of 75 or less, and smoke-developed rating of 150 or less.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Packaging: Ship insulation materials in containers marked by manufacturer with appropriate ASTM specification designation, type and grade, and maximum use temperature.

1.6 COORDINATION

- A. Coordinate size and location of supports, hangers, and insulation shields specified in Division 23 Section "Hangers and Supports."
- B. Coordinate clearance requirements with piping Installer for insulation application.

1.7 SCHEDULING

- A. Schedule insulation application after testing piping systems. Insulation application may begin on segments of piping that have satisfactory test results.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Flexible Elastomeric Thermal Insulation:
 - a. Armstrong World Industries, Inc.
 - b. Rubatex Corp.

2.2 INSULATION MATERIALS

- A. Flexible Elastomeric Thermal Insulation: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials and Type II for sheet materials.
 - 1. Adhesive: As recommended by insulation material manufacturer.
 - 2. Ultraviolet-Protective Coating: As recommended by insulation manufacturer.

2.3 FIELD-APPLIED JACKETS

- A. General: ASTM C 921, Type 1, unless otherwise indicated.
- B. Standard PVC Fitting Covers: Factory-fabricated fitting covers manufactured from 20-mil- thick, high-impact, ultraviolet-resistant PVC.
 - 1. Shapes: 45- and 90-degree, short- and long-radius elbows, tees, valves, flanges, reducers, end caps, soil-pipe hubs, traps, mechanical joints, and P-trap and supply covers for lavatories for the disabled.
 - 2. Adhesive: As recommended by insulation material manufacturer.

2.4 VAPOR RETARDERS

- A. Mastics: Materials recommended by insulation material manufacturer that are compatible with insulation materials, jackets, and substrates.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions for compliance with requirements for installation and other conditions affecting performance of insulation application.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Surface Preparation: Clean and dry pipe and fitting surfaces. Remove materials that will adversely affect insulation application.

3.3 GENERAL APPLICATION REQUIREMENTS

- A. Apply insulation materials, accessories, and finishes according to the manufacturer's written instructions; with smooth, straight, and even surfaces; free of voids throughout the length of piping, including fittings, valves, and specialties.
- B. Refer to schedules at the end of this Section for materials, forms, jackets, and thicknesses required for each piping system.
- C. Use accessories compatible with insulation materials and suitable for the service. Use accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.
- D. Apply insulation with longitudinal seams at top and bottom of horizontal pipe runs.
- E. Seal joints and seams with vapor-retarder mastic on insulation indicated to receive a vapor retarder.
- F. Apply insulation over fittings, valves, and specialties, with continuous thermal and vapor-retarder integrity, unless otherwise indicated. Refer to special instructions for applying insulation over fittings, valves, and specialties.
- G. Apply insulation with integral jackets as follows:
 - 1. Pull jacket tight and smooth.
 - 2. Circumferential Joints: Cover with 3-inch- wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip and spaced 4 inches o.c.
 - 3. Longitudinal Seams: Overlap jacket seams at least 1-1/2 inches. Apply insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap.
 - 4. Vapor-Retarder Mastics: Where vapor retarders are indicated, apply mastic on seams and joints and at ends adjacent to flanges, unions, valves, and fittings.
 - 5. At penetrations in jackets for thermometers and pressure gages, fill and seal voids with vapor-retarder mastic.
- H. Exterior Wall Penetrations: For penetrations of below-grade exterior walls, terminate insulation flush with mechanical sleeve seal. Seal terminations with vapor-retarder mastic.

- I. Interior Wall and Partition Penetrations: Apply insulation continuously through walls and floors.
- J. Fire-Rated Wall and Partition Penetrations: Apply insulation continuously through penetrations of fire-rated walls and partitions.
 - 1. Firestopping and fire-resistive joint sealers are specified in Division 7 Section "Firestopping."
- K. Floor Penetrations: Apply insulation continuously through floor assembly.
 - 1. For insulation with vapor retarders, seal insulation with vapor-retarder mastic where floor supports penetrate vapor retarder.

3.4 FLEXIBLE ELASTOMERIC THERMAL INSULATION APPLICATION

- A. Apply insulation to straight pipes and tubes as follows:
 - 1. Follow manufacturer's written instructions for applying insulation.
 - 2. Seal longitudinal seams and end joints with manufacturer's recommended adhesive. Cement to avoid openings in insulation that will allow passage of air to the pipe surface.
- B. Apply insulation to fittings and elbows as follows:
 - 1. Apply mitered sections of pipe insulation.
 - 2. Secure insulation materials and seal seams with manufacturer's recommended adhesive. Cement to avoid openings in insulation that will allow passage of air to the pipe surface.

3.5 FINISHES

- A. Flexible elastomeric Insulation: After adhesive has fully cured, apply two coats of the insulation manufacturer's recommended protective coating.

3.6 PIPING SYSTEM APPLICATIONS

- A. Insulation materials and thicknesses are specified in schedules at the end of this Section.
- B. Items Not Insulated: Unless otherwise indicated, do not apply insulation to the following systems, materials, and equipment:
 - 1. Flexible connectors.
 - 2. Vibration-control devices.
 - 3. Air chambers, unions, strainers, check valves, plug valves, and flow regulators.

3.7 INSULATION APPLICATION SCHEDULE, GENERAL

- A. Application schedules identify piping system and indicate pipe size ranges and material, thickness, and jacket requirements.

3.8 INSULATION APPLICATION SCHEDULE

- A. Service: Refrigerant Suction and Liquid Piping.

1. Operating Temperature: 35 to 50 deg F.
2. Insulation Material: Flexible Elastomeric.
3. Insulation Thickness: ½ inch.
4. Jacket: None.
5. Vapor Retarder Required: No.
6. Finish: Painted.

B. Service: Interior Condensate Drain Piping.

1. Operating Temperature: 35 to 75 deg F.
2. Insulation Material: Flexible elastomeric.
3. Insulation Thickness: ½ inches.
4. Jacket: None
5. Vapor Retarder Required: No.
6. Finish: Painted.

END OF SECTION 230719

SECTION 231100 – LIQUEFIED-PETROLEUM GAS PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes piping, specialties, and accessories for liquefied-petroleum (LPG) gas systems within buildings, and exterior underground and aboveground piping systems.

1.3 DEFINITIONS

- A. Low-Pressure Gas Piping: Operating pressure of 0.5 psig or less.
- B. Medium-Pressure Gas Piping: Operating pressure greater than 0.5 psig.
- C. Gas Service: Pipe from gas main or other source to gas point of delivery for building being served.
- D. Gas Delivery Point: Gas meter or service pressure regulator outlet, or gas service valve if gas meter is not provided.
- E. LPG: Liquefied-petroleum gas.
- F. PE: Polyethylene Plastic.
- G. IFGC: International Fuel Gas Code.

1.4 PERFORMANCE REQUIREMENTS

- A. Minimum Operating-Pressure Ratings, For Piping Containing Only Vapor;
 - 1. Piping and Valves: 125 psig, unless otherwise indicated.

1.5 SUBMITTALS

- A. General: Submit each item in this Article according to the Conditions of the Contract and Division 1 Specification Sections.
- B. Product Data for each type of gas specialty and special-duty valve. Include pressure rating, rated capacity, and settings of selected models.
- C. Welding certificates.
- D. Test reports specified in "Field Quality Control" Article in Part 3.

- E. Maintenance data for gas specialties and special-duty valves to include in the operation and maintenance manual specified in Division 1 Section "Contract Closeout."

1.6 QUALITY ASSURANCE

- A. Comply with the "International Fuel Gas Code," for gas piping materials and components; installations; and inspecting, testing, and purging.
- B. Comply with NFPA 58 "Liquefied Petroleum Gas Code," for gas piping materials and components; installations; and inspecting, testing, and purging.
- C. Comply with NFPA 70, "National Electrical Code," for electrical connections between wiring and electrically operated control devices.
- D. Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX.
- E. Provide listing/approval stamp, label, or other marking on equipment made to specified standards.
- F. Listing and Labeling: Provide equipment and accessories specified in this Section that are listed and labeled.
 - 1. Terms "Listed" and "Labeled": As defined in National Electrical Code, Article 100.
- G. Product Options: Drawings indicate size, profiles, connections, dimensional requirements, and characteristics of gas piping equipment, specialties, and accessories and are based on specific types and models indicated. Other manufacturers' equipment and components with equal performance characteristics may be considered. Refer to Division 1 Section "Substitutions."

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Handling Flammable Liquids: Remove and dispose of liquids from existing LPG piping according to requirements of authorities having jurisdiction.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Gas Stops, 2-Inch NPS and Smaller:
 - a. BrassCraft Manufacturing Co.
 - b. Conbraco Industries, Inc.
 - c. McDonald: A.Y. McDonald Mfg. Co.
 - d. Perfection Corporation: American Meter Co.
 - 2. Gas Valves, 2-Inch NPS and Smaller:
 - a. Flowserve.

- b. Homestead Valve, a division of Olson Tech., Inc.
 - c. McDonald: A.Y. McDonald Mfg. Co.
 - d. Milliken Valve Co., Inc.
3. Gas Valves, 2-1/2-Inch NPS and Larger:
- a. Flowserve.
 - b. Homestead Valve, a division of Olson Tech., Inc.
 - c. Milliken Valve Co., Inc.

2.2 PIPES AND TUBES

- A. Steel Pipe: ASTM A53/A53M, black steel, Schedules 40, Type E or S, Grade B.
 - 1. Malleable-Iron Threaded Fittings: ASME B16.3, Class 150, standard pattern.
 - 2. Wrought-Steel Welding Fittings: ASTM A234/A234M for butt welding and socket welding.
 - 3. Unions: ASME B16.39, Class 150, malleable iron with brass-to-iron seat, ground joint, and threaded ends.
 - 4. Forged-Steel Flanges and Flanged Fittings: ASME B16.5, minimum Class 150, including bolts, nuts, and gaskets of the following material group, end connections, and facings:
 - a. Material Group: 1.1.
 - b. End Connections: Threaded or butt welding to match pipe.
 - c. Lapped Face: Not permitted underground.
 - d. Gasket Materials: ASME B16.20, metallic, flat, asbestos free, aluminum o-rings, and spiral-wound metal gaskets.
 - e. Bolts and Nuts: ASME B18.2.1, stainless steel.
- B. P.E. Pipe: ASTM D 2513, SDR 11.
- C. P.E. Fittings: ASTM D 3261, butt type with dimensions matching piping.

2.3 JOINING MATERIALS

- A. Common Joining Materials: Refer to Division 23 Section "Basic HVAC Materials and Methods" for joining materials not included in this Section.
- B. Joint Compound and Tape: Suitable for LPG.
- C. Welding Filler Metals: Comply with AWS D10.12/D10.12M for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.
- D. Gasket Material: Thickness, material, and type suitable for LPG.

2.4 VALVES

- A. Manual Valves: Conform to standards listed or, where appropriate, to ANSI Z21.15.
- B. Gas Stops, 2-Inch NPS and Smaller: AGA-certified, bronze-body, plug type with bronze plug, or ball type with chrome-plated brass ball, and fluorocarbon elastomer seal, for

2 psig or less LPG. Include AGA stamp, flat or square head or lever handle, and threaded ends conforming to ASME B1.20.1.

- C. Gas Valves, 2-Inch NPS and Smaller: ASME B16.33, rated for 175 psig, iron body, bronze plug, straightaway pattern, square head with lockwing, tapered-plug type, tamper-resistant, with threaded ends conforming to ASME B1.20.1. Valves shall be suitable for LPG service, with “WOG” indicated on valve body. Painted, suitable for exterior environment.
- D. Gas Valves, 2-1/2-Inch NPS and Larger: MSS SP-78, Class 125 or Class 175 WOG, lubricated-plug type, semisteel body, wrench operated, with flanged ends. Valves shall be suitable for LPG service with “WOG” indicated on valve body.

2.5 PIPING SPECIALTIES

- A. Flexible Connectors: ANSI Z21.24, stainless steel.
- B. Service Line Risers: PE pipe with coated, annodeless, steel pipe casing on riser section. Include inlet for heat-fusion connection to PE pipe and outlet for connection to above ground steel piping.

2.6 LABELING AND IDENTIFYING

- A. Detectable Warning Tape: Acid- and alkali-resistant PE film warning tape manufactured for marking and identifying underground utilities, a minimum of 6 inches wide and 4 mils thick, continuously inscribed with a description of utility, with metallic core encased in a protective jacket for corrosion protection, detectable by metal detector when tape is buried up to 30 inches deep; colored yellow.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine roughing-in for LPG piping system to verify actual locations of piping connections before equipment installation.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 EARTHWORK

- A. Excavation, trenching, and backfilling are specified in Division 33 Sections.

3.3 PREPARATION

- A. Comply with all procedures in accordance with NFPA 58 and the IFGC.
- B. Close equipment shutoff valves before turning off LPG to premises or piping section.

- C. Inspect LPG piping according to NFPA 58 and the International Fuel Gas Code to determine that LPG utilization devices are turned off in piping section affected.
- D. Comply with NFPA 58 and the International Fuel Gas Code requirements for prevention of accidental ignition.

3.4 SERVICE ENTRANCE PIPING

- A. Extend LPG piping and connect to exterior LPG system (gas service) piping in locations and sizes indicated on the plans.

3.5 PIPING APPLICATIONS

- A. General: Flanges, unions, transition and special fittings, and valves with pressure ratings same as or higher than system pressure rating may be used in applications below, except where otherwise indicated.
- B. Aboveground Low-Pressure LPG Systems: Use the following:
 - 1. 2-Inch NPS and Smaller: Steel pipe, malleable-iron threaded fittings, and threaded joints.
 - 2. 2-1/2-Inch NPS and Larger: Steel pipe, wrought-steel fittings, and butt-welded joints.
- C. Aboveground LPG Systems for System Pressures more than 0.5 psig and less than 5 psig: Use the following:
 - 1. 2-Inch NPS and Smaller: Steel pipe, malleable-iron threaded fittings, and threaded joints.
- D. Aboveground LPG Systems for System Pressures 5 psig and greater: Use the following:
 - 1. 2-Inch NPS and Smaller: Steel pipe, wrought-steel fittings, and butt-welded joints.
- E. Underground Natural Gas Systems: Use the following:
 - 1. Use PE pipe, PE fittings, and Heat-Fusion joints.
- F. Underground-to-Aboveground Piping Connections: Service-line riser.

3.6 VALVE APPLICATIONS

- A. Interior Locations: Use gas stops for shutoff to appliances 2-inch NPS or smaller.
- B. Use gas valves for shutoff to exterior appliances, and for exterior gas piping systems.
- C. Use gas valves of sizes indicated for shutoff at buildings, mains, appliances, and where indicated.

3.7 ABOVEGROUND PIPING INSTALLATIONS

- A. Refer to Division 23 Section "Basic HVAC Materials and Methods" for basic piping installation requirements.

- B. Concealed Locations: Except as specified below, install concealed gas piping in airtight conduit constructed of Schedule 40, seamless, black steel pipe with welded joints. Vent conduit to outside and terminate with screened vent cap.
1. Above-Ceiling Locations: Gas piping may be installed in accessible spaces, subject to approval of authorities having jurisdiction, whether or not such spaces are used as plenums. Do not locate valves in such spaces.
 2. In Floors: Gas piping with welded joints and protective wrapping specified in "Protective Coating" Article in Part 2 may be installed in floors, subject to approval of authorities having jurisdiction. Surround piping cast in concrete slabs with minimum of 1-1/2 inches of concrete. Piping may not be in physical contact with other metallic structures such as reinforcing rods or electrically neutral conductors. Do not embed piping in concrete slabs containing quick-set additives or cinder aggregate.
 3. In Floor Channels: Gas piping may be installed in floor channels, subject to approval of authorities having jurisdiction. Channels must have cover and be open to space above cover for ventilation.
 4. In Partitions: Do not install concealed piping in solid partitions. Protect tubing from physical damage when installed inside partitions or hollow walls.
 - a. Exception: Tubing passing through partitions or walls.
 5. In Walls: Gas piping with welded joints and protective wrapping specified in "Protective Coating" Article in Part 2 may be installed in masonry walls, subject to approval of authorities having jurisdiction.
 6. Prohibited Locations: Do not install gas piping in or through circulating air ducts, clothes or trash chutes, chimneys or gas vents (flues), ventilating ducts, or dumbwaiter or elevator shafts.
 - a. Exception: Accessible above-ceiling space specified above.
- C. Drips and Sediment Traps: Install drips at points where condensate may collect. Include outlets of gas meters. Locate where readily accessible to permit cleaning and emptying. Do not install where condensate would be subject to freezing.
1. Construct drips and sediment traps using tee fitting with bottom outlet plugged or capped. Use minimum-length nipple of 3 pipe diameters, but not less than 3 inches long, and same size as connected pipe. Install with space between bottom of drip and floor for removal of plug or cap.
- D. Conceal pipe installations in walls, pipe spaces, utility spaces, above ceilings, below grade or floors, and in floor channels, except where indicated to be exposed to view.
- E. Install LPG piping at uniform grade of 2 percent down toward drip and sediment traps.
- F. Use eccentric reducer fittings to make reductions in pipe sizes. Install fittings with level side down.
- G. Connect branch piping from top or side of horizontal piping.
- H. Install unions in pipes 2-inch NPS and smaller, adjacent to each valve, at final connection to equipment, and elsewhere as indicated. Unions are not required on flanged devices.
- I. Install dielectric fittings (unions and flanges) with ferrous and brass or bronze end connections, separated by insulating material, where piping of dissimilar metals is joined.

- J. Install dielectric fittings (unions and flanges) with 2 ferrous end connections, separated by insulating material, at outlet from gas meter and, where indicated, for ferrous piping.
- K. Install flanges on valves and equipment having 2-1/2-inch NPS and larger connections.
- L. Anchor piping to ensure proper direction of piping expansion and contraction. Install expansion joints, expansion loops, and pipe guides as indicated.
- M. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 230512 "Basic HVAC Materials and Methods."
- N. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 230512 "Basic HVAC Materials and Methods."

3.8 UNDERGROUND PIPING INSTALLATION

- A. Install underground, LPG piping with bury depth as indicated on the plans, or 36-inches bury depth if not indicated.
- B. Install underground, PE, gas piping according to ASTM D 2774.
- C. Warning Tapes: Arrange for installation of continuous, underground, detectable warning tape over LPG piping during backfilling of trenches for piping.

3.9 JOINT CONSTRUCTION

- A. Refer to Division 23 Section "Basic HVAC Materials and Methods" for basic piping joint construction.
- B. Use materials suitable for LPG.

3.10 VALVE INSTALLATION

- A. Install valves in accessible locations, protected from damage.

3.11 HANGER AND SUPPORT INSTALLATION

- A. Refer to Division 23 Section "Hangers and Supports" for pipe hanger and support devices.
- B. Install hangers for horizontal steel piping with the following maximum spacing and minimum rod sizes:
 1. 1/2-Inch NPS: Maximum span, 72 inches; minimum rod size, 3/8 inch.
 2. 3/4- and 1-Inch NPS: Maximum span, 96 inches; minimum rod size, 3/8 inch.
 3. 1-1/4-Inch to 2-Inch NPS: Maximum span, 108 inches; minimum rod size, 3/8 inch.
 4. 2-1/2-Inch NPS to 3-1/2 NPS: Maximum span, 10 feet; minimum rod size, 1/2 inch.

5. 4-Inch NPS and Larger: Maximum span, 10 feet; minimum rod size, 5/8 inch.

C. Support vertical pipe and tube at each floor.

3.12 CONNECTIONS

A. Install gas piping next to appliances using gas to allow service and maintenance.

B. Connect gas piping to equipment and appliances using gas shutoff valves and unions. Install gas valve upstream from and within 72 inches of each appliance. Install union or flanged connection downstream from valve. Include flexible connectors when indicated or required by appliance manufacturer.

C. Sediment Traps: Install tee fitting with capped nipple in bottom forming drip, as close as practical to inlet for appliance using gas.

3.13 ELECTRICAL BONDING AND GROUNDING

A. Install aboveground portions of LPG piping systems that are upstream from equipment shutoff valves, electrically continuous, and bonded to grounding electrode according to NFPA 70.

B. Do not use gas piping as grounding electrode.

3.14 PAINTING

A. Materials and procedures are specified in Division 9 Sections.

B. All exterior and interior piping and fittings to be painted.

3.15 FIELD QUALITY CONTROL

A. Inspect, test, and purge piping according to the NFPA 58 and the International Fuel Gas Code, and requirements of authorities having jurisdiction.

B. Repair leaks, defects with new materials and retest system until results are satisfactory.

C. Verify capacities and pressure ratings of gas regulators, valves, and specialties. Verify correct pressure settings for pressure regulators.

D. Adjust controls and safety devices. Replace damaged and malfunctioning controls and safety devices.

E. Report inspection and test results promptly, and in writing to Engineer and authorities having jurisdiction.

END OF SECTION 231100

SECTION 232113 - HYDRONIC PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section includes pipe and fitting materials and joining methods for the following:
 1. Plastic pipe and fittings.
 2. Joining materials.

1.3 SUBMITTALS

- A. Product Data: For each type of the following:
 1. Pipe.
 2. Fittings.
 3. Joining materials.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Hydronic piping components and installation shall be capable of withstanding the following minimum working pressure and temperature unless otherwise indicated:
 1. Condensate-Drain Piping: 150 deg F.

2.2 PLASTIC PIPE AND FITTINGS

- A. PVC Plastic Pipe: ASTM D1785, with wall thickness as indicated in "Piping Applications" Article.
 1. PVC Plastic Pipe Fittings: Socket-type pipe fittings, ASTM D2466 for Schedule 40 pipe; ASTM D2467 for Schedule 80 pipe.

2.3 JOINING MATERIALS

- A. Plastic, Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer unless otherwise indicated.
- B. Solvent Cements for PVC Piping: ASTM D2564. Include primer according to ASTM F656.

PART 3 - EXECUTION

3.1 PIPING APPLICATIONS

- A. Condensate-Drain Piping: Schedule 40 PVC plastic pipe and fittings and solvent-welded joints.

3.2 PIPING INSTALLATIONS

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.
- B. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.
- C. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- D. Install piping above ceilings to allow sufficient space for ceiling panel removal.
- E. Install piping to permit valve servicing.
- F. Install piping at indicated slopes.
- G. Install piping free of sags and bends.
- H. Install fittings for changes in direction and branch connections.
- I. Install piping to allow application of insulation.
- J. Select system components with pressure rating equal to or greater than system operating pressure.
- K. Install unions in piping, NPS 2 and smaller, adjacent to valves, at final connections of equipment, and elsewhere as indicated.
- L. Comply with requirements in Section 230553 "Identification for HVAC Piping and Equipment" for identifying piping.
- M. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Division 23 Sections.
- N. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Division 23 Sections.

3.3 HANGERS AND SUPPORTS

- A. Comply with requirements in Section 230529 "Hangers and Supports for HVAC Piping and Equipment" for hanger, support, and anchor devices. Comply with the following requirements for maximum spacing of supports.
- B. Install the following pipe attachments:
 - 1. Adjustable steel clevis hangers for individual horizontal piping less than 20 feet long.
 - 2. On plastic pipe, install pads or cushions on bearing surfaces to prevent hanger from scratching pipe.
- C. Plastic Piping Hanger Spacing: Space hangers according to pipe manufacturer's written instructions for service conditions. Avoid point loading.
- D. Support vertical runs at roof, at each floor, and at 10-foot intervals between floors.

3.4 PIPE JOINT CONSTRUCTION

- A. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
- B. Plastic Piping Solvent-Cemented Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:
 - 1. Comply with ASTM F402 for safe-handling practice of cleaners, primers, and solvent cements.
 - 2. PVC Pressure Piping: Join ASTM D1785 schedule number, PVC pipe and PVC socket fittings according to ASTM D2672. Join other-than-schedule number PVC pipe and socket fittings according to ASTM D2855.
 - 3. PVC Nonpressure Piping: Join according to ASTM D2855.

END OF SECTION 232113

SECTION 233113 - METAL DUCTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes metal and nonmetal ducts for supply, return, outside, and exhaust air-distribution systems in pressure classes from minus 2- to plus 2-inch wg. Metal ducts include the following:
 - 1. Rectangular ducts and fittings.
 - 2. Single-wall, round spiral-seam ducts and formed fittings.
- B. Related Sections include the following:
 - 1. Section 233300 "Duct Accessories" for dampers, sound-control devices, duct-mounting access doors and panels, turning vanes, and flexible ducts.
 - 2. Section 230593 "Testing, Adjusting, and Balancing".
- C. Duct system design, as indicated, has been used to select size and type of air-moving and -distribution equipment and other air system components. Changes to layout or configuration of duct system must be specifically approved in writing by Engineer. Accompany requests for layout modifications with calculations showing that proposed layout will provide original design results without increasing system total pressure.

1.3 SUBMITTALS

- A. Manufacturer's Product Data: Round and spiral lockseam ducts.

1.4 QUALITY ASSURANCE

- A. NFPA Compliance:
 - 1. NFPA 90A, "Installation of Air Conditioning and Ventilating Systems."
 - 2. NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems."

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 DUCT MATERIALS

- A. Comply with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods, unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.
- B. Stainless-Steel Sheets: Comply with ASTM A480/A480M, Type 316, cold rolled, annealed, sheet. Exposed surface finish shall be No. 3 or No. 4.
- C. Aluminum Sheets: ASTM B 209, alloy 3003, temper H14; with mill finish for concealed ducts and standard, 1-side bright finish for exposed ducts. Material thicknesses shall comply with SMACNA's "Industrial Duct Construction Standards".
- D. Galvanized Sheet Steel: Lock-forming quality; complying with ASTM A 653/A 653M and having G90 coating designation; ducts shall have mill-phosphatized finish for surfaces exposed to view.
- E. Reinforcement Shapes and Plates: Galvanized-steel where installed on galvanized sheet metal ducts. Stainless-steel where installed on stainless-steel ducts. Where used on aluminum ducts, isolate the different metals with neoprene, butyl rubber, or EPDM gasket materials.
- F. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for lengths 36 inches or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

2.3 SEALANT MATERIALS

- A. Joint and Seam Sealants, General: The term "sealant" is not limited to materials of adhesive or mastic nature but includes tapes and combinations of open-weave fabric strips and mastics.
- B. Water-Based Joint and Seam Sealant: Flexible, adhesive sealant, resistant to UV light when cured, UL 723 listed, and complying with NFPA requirements for Class 1 ducts.
- C. Flanged Joint Mastic: One-part, acid-curing, silicone, elastomeric joint sealant complying with ASTM C 920, Type S, Grade NS, Class 25, Use O.
- D. Flange Gaskets: Butyl rubber or EPDM polymer with polyisobutylene plasticizer.

2.4 HANGERS AND SUPPORTS

- A. Building Attachments: Concrete inserts, powder-actuated fasteners, or structural-steel fasteners appropriate for construction materials to which hangers are being attached.
 - 1. Use powder-actuated concrete fasteners for standard-weight aggregate concretes or for slabs more than 4 inches thick.
 - 2. Exception: Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes or for slabs less than 4 inches thick.
- B. Special Hanger Materials:

1. General: All hangers, supports, rods, etc. to be corrosion resistant, hot dipped galvanized for interior, and Type 316 or 304 stainless steel for exterior, except as noted otherwise.
- C. Hanger Type: Threaded rod. Straps and wires are not permitted.
 1. Rod Sizes: Comply with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for rod diameters.
- D. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.
- E. Trapeze and Riser Supports:
 1. Supports for Stainless-Steel Ducts: Stainless steel shapes and plates.

2.5 RECTANGULAR DUCT FABRICATION

- A. Fabricate ducts, elbows, transitions, offsets, branch connections, and other construction according to SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" and complying with requirements for metal thickness, reinforcing types and intervals, tie-rod applications, and joint types and intervals.
 1. Lengths: Fabricate rectangular ducts in lengths appropriate to reinforcement and rigidity class required for pressure class.
 2. Deflection: Duct systems shall not exceed deflection limits according to SMACNA's "HVAC Duct Construction Standards--Metal and Flexible."
- B. Transverse Joints: Prefabricated slide-on joints and components constructed using manufacturer's guidelines for material thickness, reinforcement size and spacing, and joint reinforcement.
 1. Manufacturers:
 - a. Ductmate Industries, Inc.
 - b. Nexus Inc.
 - c. Ward Industries, Inc.
- C. Formed-On Flanges: Construct according to SMACNA's "HVAC Duct Construction Standards--Metal and Flexible," Figure 1-4, using corner, bolt, cleat, and gasket details.
 1. Manufacturers:
 - a. Ductmate Industries, Inc.
 - b. Lockformer.
 2. Duct Size: Maximum 30 inches wide and up to 2-inch wg pressure class.
 3. Longitudinal Seams: Pittsburgh lock sealed with noncuring polymer sealant.
- D. Cross Breaking or Cross Beading: Cross break or cross bead duct sides 19 inches and larger and 0.0359 inch thick or less, with more than 10 sq. ft. of nonbraced panel area unless ducts are lined.

2.6 ROUND AND OVAL DUCT AND FITTING FABRICATION

- A. Manufacturers:
 1. Ductmate Industries, Inc.
 2. Lindab, Inc.

3. McGill AirFlow Corporation.
 4. SEMCO Incorporated.
- B. Diameter as applied to flat-oval ducts in this Article is the diameter of a round duct with a circumference equal to the perimeter of a given size of flat-oval duct.
- C. Round, Longitudinal- and Spiral Lock-Seam Ducts: Fabricate supply ducts of galvanized steel according to SMACNA's "HVAC Duct Construction Standards--Metal and Flexible."
- D. Duct Joints:
1. Ducts up to 20 Inches in Diameter: Interior, center-beaded slip coupling, sealed before and after fastening, attached with sheet metal screws.
 2. Ducts 21 to 72 Inches in Diameter: Three-piece, gasketed, flanged joint consisting of two internal flanges with sealant and one external closure band with gasket.
 3. Round Ducts: Prefabricated connection system consisting of double-lipped, EPDM rubber gasket. Manufacture ducts according to connection system manufacturer's tolerances.
- E. 90-Degree Tees and Laterals and Conical Tees: Fabricate to comply with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible," with metal thicknesses specified for longitudinal-seam straight ducts.
- F. Diverging-Flow Fittings: Fabricate with reduced entrance to branch taps and with no excess material projecting from fitting onto branch tap entrance.
- G. Fabricate elbows using die-formed, gored, pleated, or mitered construction. Bend radius of die-formed, gored, and pleated elbows shall be 1-1/2 times duct diameter. Unless elbow construction type is indicated, fabricate elbows as follows:
1. Round Mitered Elbows: Welded construction with the following metal thickness for pressure classes from 2- to 10-inch wg:
 - a. Ducts 3 to 26 Inches in Diameter: 0.034 inch.
 - b. Ducts 27 to 50 Inches in Diameter: 0.040 inch.
 2. Flat-Oval Mitered Elbows: Welded construction with same metal thickness as longitudinal-seam flat-oval duct.
 3. 90-Degree, 2-Piece, Mitered Elbows: Use only for supply systems or for material-handling Class A or B exhaust systems and only where space restrictions do not permit using radius elbows. Fabricate with single-thickness turning vanes.
 4. Round Elbows 8 Inches and Less in Diameter: Fabricate die-formed elbows for 45- and 90-degree elbows and pleated elbows for 30, 45, 60, and 90 degrees only. Fabricate nonstandard bend-angle configurations or nonstandard diameter elbows with gored construction.
 5. Round Elbows 9 through 14 Inches in Diameter: Fabricate gored or pleated elbows for 30, 45, 60, and 90 degrees unless space restrictions require mitered elbows. Fabricate nonstandard bend-angle configurations or nonstandard diameter elbows with gored construction.
 6. Round Elbows Larger Than 14 Inches in Diameter and All Flat-Oval Elbows: Fabricate gored elbows unless space restrictions require mitered elbows.

PART 3 - EXECUTION

3.1 DUCT APPLICATIONS

- A. Static-Pressure Classes: Unless otherwise indicated, construct ducts according to the following:
 - 1. Supply Ducts: 2-inch wg with seal Class A seams and joint construction.
 - 2. Return Ducts (Negative Pressure): 2-inch wg with seal Class A seams and joint construction.
 - 3. Exhaust Ducts (Negative Pressure): 2-inch wg with seal Class A seams and joint construction.
 - 4. Exhaust Ducts (Positive Pressure): 2-inch wg with seal Class A seams and joint construction.

- B. Duct Materials: Duct materials shall be as follows:
 - 1. Galvanized Steel Duct Systems:
 - a. RTU-1 Rooftop Unit (Admin-Operations' Building): supply-air and return-air systems.
 - b. EF-3,4,5 Exhaust Fans (Admin-Operations' Building): exhaust-air systems.

 - 2. Type 316 Stainless-Steel Duct Systems:
 - a. EF-2 Exhaust Fan (Tertiary Filter Building): exhaust-air systems.

 - 3. Aluminum Duct Systems:
 - a. MAU-1 Makeup Air Unit, and IH-1 Intake Hood (Sludge Transfer Lift Station): outside-air systems, and supply-air systems.
 - b. EF-1 Exhaust Fan (Sludge Transfer Lift Station): exhaust-air systems.
 - c. MAU-2 Makeup Air Unit (Tertiary Filter Building): supply-air systems.
 - d. MAU-3 Makeup Air Unit (Headworks Building): supply-air systems.
 - e. ACU-1 Air Conditioning Unit (Laboratory): outside-air systems.

- C. Round Duct Type:
 - 1. Exposed: Spiral Lockseam.
 - 2. Concealed: Longitudinal or Spiral Lockseam.

3.2 DUCT INSTALLATION

- A. Construct and install ducts according to SMACNA's "HVAC Duct Construction Standards--Metal and Flexible," unless otherwise indicated.

- B. Install round and flat-oval ducts in lengths not less than 12 feet unless interrupted by fittings.

- C. Install ducts with fewest possible joints.

- D. Install fabricated fittings for changes in directions, size, and shape and for connections.

- E. Install couplings tight to duct wall surface with a minimum of projections into duct. Secure couplings with sheet metal screws. Install screws at intervals of 12 inches, with a minimum of 3 screws in each coupling.
- F. Install ducts, unless otherwise indicated, vertically and horizontally and parallel and perpendicular to building lines; avoid diagonal runs.
- G. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.
- H. Install ducts with a clearance of 1 inch, plus allowance for insulation thickness.
- I. Conceal ducts from view in finished spaces. Do not encase horizontal runs in solid partitions unless specifically indicated.
- J. Coordinate layout with suspended ceiling, fire- and smoke-control dampers, lighting layouts, and similar finished work.
- K. Seal all joints and seams. Apply sealant to male end connectors before insertion, and afterward to cover entire joint and sheet metal screws.
- L. Non-Fire-Rated Partition Penetrations: Where ducts pass through interior partitions and exterior walls and are exposed to view, conceal spaces between construction openings and ducts or duct insulation with sheet metal flanges of same metal thickness as ducts. Overlap openings on 4 sides by at least 1-1/2 inches.
- M. Fire-Rated Partition Penetrations: Where ducts pass through interior partitions and exterior walls, install appropriately rated fire dampers, sleeves, and firestopping sealant. Fire and smoke dampers are specified in Division 23 Section "Duct Accessories." Firestopping materials and installation methods are specified in Division 7 Section "Through-Penetration Firestop Systems."
- N. Protect duct interiors from the elements and foreign materials until building is enclosed. Follow SMACNA's "Duct Cleanliness for New Construction."

3.3 SEAM AND JOINT SEALING

- A. Seal duct seams and joints according to SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for duct pressure class indicated.

3.4 HANGING AND SUPPORTING

- A. Support horizontal ducts within 24 inches of each elbow and within 48 inches of each branch intersection.
- B. Support vertical ducts at maximum intervals of 16 feet and at each floor.
- C. Install upper attachments to structures with an allowable load not exceeding one-fourth of failure (proof-test) load.

- D. Install powder-actuated concrete fasteners after concrete is placed and completely cured.
 - 1. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes or for slabs less than 4 inches thick.

3.5 CONNECTIONS

- A. Make connections to equipment with flexible connectors according to Division 23 Section "Duct Accessories."
- B. Comply with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for branch, outlet and inlet, and terminal unit connections.

END OF SECTION 233113

SECTION 233300 - DUCT ACCESSORIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes the following:
 1. Volume dampers.
 2. Fire dampers.
 3. Turning vanes.
 4. Duct-mounting access doors.
 5. Flexible connectors.
 6. Duct accessory hardware.

1.3 SUBMITTALS

- A. Product Data: All items specified and utilized on Project.

1.4 QUALITY ASSURANCE

- A. Comply with NFPA 90A, "Installation of Air Conditioning and Ventilating Systems," and NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems."

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 VOLUME DAMPERS

- A. Manufacturers:
 1. Air Balance, Inc.
 2. American Warming and Ventilating.
 3. Flexmaster U.S.A., Inc.
 4. McGill AirFlow Corporation.
 5. METALAIRE, Inc.
 6. Nailor Industries Inc.
 7. Penn Ventilation Company, Inc.

8. Ruskin Company.
 9. Vent Products Company, Inc.
- B. General Description: Factory fabricated, with required hardware and accessories. Stiffen damper blades for stability. Include locking device to hold single-blade dampers in a fixed position without vibration. Close duct penetrations for damper components to seal duct consistent with pressure class.
- C. Standard Volume Dampers: Multiple- or single-blade, parallel- or opposed-blade design as indicated, standard leakage rating, with linkage outside airstream, and suitable for horizontal or vertical applications.
1. Steel Frames: Hat-shaped, galvanized sheet steel channels, minimum of 0.064 inch thick, with mitered and welded corners; frames with flanges where indicated for attaching to walls and flangeless frames where indicated for installing in ducts. Minimum of 0.05 stainless steel for stainless steel duct systems.
 2. Roll-Formed Steel Blades: 0.064-inch- thick, galvanized sheet steel for galvanized duct systems, stainless steel for stainless steel duct systems.
 3. Aluminum Frames: Hat-shaped, 0.10-inch- thick, aluminum sheet channels; frames with flanges where indicated for attaching to walls; and flangeless frames where indicated for installing in ducts.
 4. Roll-Formed Aluminum Blades: 0.10-inch- thick aluminum sheet.
 5. Blade Axles: Galvanized steel for galvanized steel duct systems, stainless steel for stainless steel duct systems.
 6. Bearings: Molded synthetic.
 7. Tie Bars and Brackets: Aluminum.
 8. Tie Bars and Brackets: Galvanized steel.
- D. Jackshaft: 1-inch-diameter, galvanized-steel pipe rotating within pipe-bearing assembly mounted on supports at each mullion and at each end of multiple-damper assemblies.
1. Length and Number of Mountings: Appropriate to connect linkage of each damper in multiple-damper assembly.
- E. Damper Hardware: Zinc-plated, die-cast core with dial and handle made of 3/32-inch-thick zinc-plated steel, and a 3/4-inch hexagon locking nut. Include center hole to suit damper operating-rod size. Include elevated platform for insulated duct mounting.

2.3 FIRE DAMPERS

- A. Type: Dynamic; rated and labeled according to UL 555 by an NRTL.
- B. Closing rating in ducts up to 4-inch wg static pressure class and minimum 2000-fpm velocity.
- C. Fire Rating: 3 hours.
- D. Frame: Curtain type with blades outside of airstream; fabricated with roll-formed, type-304 stainless steel; with mitered and interlocking corners.
- E. Mounting Sleeve: Factory-installed, type-304 stainless sheet steel.

- F. Mounting Orientation: Vertical or horizontal as indicated.
- G. Blades: Roll-formed, interlocking, type-304 stainless sheet steel.
- H. Horizontal Dampers: Include blade lock and stainless-steel closure spring.
- I. Heat-Responsive Device: Replaceable, 165 deg F rated, fusible links.

2.4 TURNING VANES

- A. Fabricate to comply with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for vanes and vane runners. Vane runners shall automatically align vanes.
- B. Manufactured Turning Vanes: Fabricate 1-1/2-inch- wide, single-vane, curved blades of galvanized sheet steel set 3/4 inch o.c.; support with bars perpendicular to blades set 2 inches o.c.; and set into vane runners suitable for duct mounting.
 - 1. Manufacturers:
 - a. Ductmate Industries, Inc.
 - b. Duro Dyne Corp.
 - c. METALAIRE, Inc.
 - d. Ward Industries, Inc.
- C. Acoustic Turning Vanes: Fabricate airfoil-shaped aluminum extrusions with perforated faces and fibrous-glass fill.

2.5 DUCT-MOUNTING ACCESS DOORS

- A. General Description: Fabricate doors airtight and suitable for duct pressure class.
- B. Door: Double wall, duct mounting, and rectangular; fabricated of galvanized sheet metal with 1-inch thick insulation fill. Include butt or piano hinge and cam latches.
 - 1. Manufacturers:
 - a. American Warming and Ventilating.
 - b. CESCO Products.
 - c. Ductmate Industries, Inc.
 - d. Flexmaster U.S.A., Inc.
 - e. Greenheck.
 - f. McGill AirFlow Corporation.
 - g. Nailor Industries Inc.
 - h. Ventfabrics, Inc.
 - i. Ward Industries, Inc.
 - 2. Frame: Galvanized sheet steel, with bend-over tabs and foam gaskets.
- C. Seal around frame attachment to duct and door to frame with neoprene or foam rubber.

2.6 FLEXIBLE CONNECTORS

- A. Manufacturers:
 - 1. Duro Dyne Corp.
 - 2. Ventfabrics, Inc.

3. Ward Industries, Inc.
 - B. General Description: Flame-retardant or noncombustible fabrics, coatings, and adhesives complying with UL 181, Class 1.
 - C. Metal-Edged Connectors: Factory fabricated with a fabric strip 3-1/2 inches wide attached to two strips of 2-3/4-inch- wide, 0.028-inch- thick, galvanized sheet steel or 0.032-inch- thick aluminum sheets. Select metal compatible with ducts.
 - D. Indoor System, Flexible Connector Fabric: Glass fabric double coated with neoprene.
 1. Minimum Weight: 26 oz./sq. yd..
 2. Tensile Strength: 480 lbf/inch in the warp and 360 lbf/inch in the filling.
 3. Service Temperature: Minus 40 to plus 200 deg F.
 - E. Outdoor System, Flexible Connector Fabric: Glass fabric double coated with weatherproof, synthetic rubber resistant to UV rays and ozone.
 1. Minimum Weight: 24 oz./sq. yd.
 2. Tensile Strength: 530 lbf/inch in the warp and 440 lbf/inch in the filling.
 3. Service Temperature: Minus 50 to plus 250 deg F.

2.7 DUCT ACCESSORY HARDWARE

- A. Instrument Test Holes: Cast iron or cast aluminum to suit duct material, including screw cap and gasket. Size to allow insertion of pitot tube and other testing instruments and of length to suit duct insulation thickness.
- B. Adhesives: High strength, quick setting, neoprene based, waterproof, and resistant to gasoline and grease.

PART 3 - EXECUTION

3.1 APPLICATION AND INSTALLATION

- A. Install duct accessories according to applicable details in SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for metal ducts and in NAIMA AH116, "Fibrous Glass Duct Construction Standards," for fibrous-glass ducts.
- B. Provide duct accessories of materials suited to duct materials; use galvanized-steel accessories in galvanized-steel and fibrous-glass ducts, stainless-steel accessories in stainless-steel ducts, and aluminum accessories in aluminum ducts.
- C. Provide balancing dampers at points on supply, return, and exhaust systems where branches lead from larger ducts as required for air balancing. Install at a minimum of two duct widths from branch takeoff.
- D. Install fire dampers according to UL listing. Install access doors at all fire dampers.
- E. Install duct access doors to allow for inspecting, adjusting, and maintaining accessories and where indicated on the plans.

- F. Label access doors according to Division 23 Section “Mechanical Identification.”
- G. Install flexible connectors immediately adjacent to equipment in ducts associated with fans and motorized equipment supported by vibration isolators and where ducts are installed perpendicular to building structural expansion joints.

3.2 ADJUSTING

- A. Adjust duct accessories for proper settings.

END OF SECTION 233300

SECTION 233423 - POWER VENTILATORS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Centrifugal roof and wall ventilators.

1.3 PERFORMANCE REQUIREMENTS

- A. Project Altitude: Base fan-performance ratings on sea level.
- B. Operating Limits: Classify according to AMCA 99.

1.4 SUBMITTALS

- A. Product Data: Include rated capacities, furnished specialties, and accessories for each type of product indicated and include the following:
 - 1. Certified fan performance curves with system operating conditions indicated.
 - 2. Certified fan sound-power ratings.
 - 3. Motor ratings and electrical characteristics, plus motor and electrical accessories.
 - 4. Material thickness and finishes, including color charts.
 - 5. Dampers, including housings, linkages, and operators.
 - 6. Fan speed controllers.
- B. Wiring Diagrams: Power, signal, and control wiring.
- C. Field quality-control test reports.
- D. Operation and Maintenance Data: For power ventilators to include in emergency, operation, and maintenance manuals.

1.5 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

- B. AMCA Compliance: Products shall comply with performance requirements and shall be licensed to use the AMCA-Certified Ratings Seal.
- C. NEMA Compliance: Motors and electrical accessories shall comply with NEMA standards.
- D. UL Standard: Power ventilators shall comply with UL 705.

1.6 COORDINATION

- A. Coordinate size and location of structural-steel support members.
- B. Coordinate installation of roof curbs, equipment supports, and penetrations.

1.7 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Belts: One set for each belt-driven unit.

PART 2 - PRODUCTS

2.1 CENTRIFUGAL ROOF VENTILATORS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Ammerman; General Resource Corp.
 - 2. Greenheck.
 - 3. JencoFan; Div. of Breidert Air Products.
 - 4. Loren Cook Company.
 - 5. Penn Ventilation.
- B. Description: Belt-driven centrifugal fans consisting of housing, wheel, fan shaft, bearings, motor, drive assembly, and accessories. Direct-driven fans shall be provided where indicated on the plans (See Equipment Schedules).
- C. Housing: Heavy-gage, removable, spun-aluminum, dome top and outlet baffle; venturi inlet cone.
- D. Fan Wheel: Aluminum hub and wheel with backward-inclined blades.
- E. Belt-Driven Drive Assembly: Resiliently mounted to housing, with the following features:

1. Fan Shaft: Turned, ground, and polished steel; keyed to wheel hub.
2. Shaft Bearings: Permanently lubricated, permanently sealed, self-aligning ball bearings.
3. Pulleys: Cast-iron, adjustable-pitch motor pulley.
4. Fan and motor isolated from exhaust airstream.

F. Accessories:

1. See "Mechanical Equipment Schedules" on the plans for all construction features, coatings, motor types, and other accessories.

G. Coatings, when specified, shall be applied to all fan items and accessories.

2.2 MOTORS

1. See "HVAC Equipment Schedule" on the Plans.

2.3 SOURCE QUALITY CONTROL

- A. Sound-Power Level Ratings: Comply with AMCA 301, "Methods for Calculating Fan Sound Ratings from Laboratory Test Data." Factory test fans according to AMCA 300, "Reverberant Room Method for Sound Testing of Fans." Label fans with the AMCA-Certified Ratings Seal.
- B. Fan Performance Ratings: Establish flow rate, pressure, power, air density, speed of rotation, and efficiency by factory tests and ratings according to AMCA 210, "Laboratory Methods of Testing Fans for Rating."

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install power ventilators level and plumb, in accordance with manufacturer's installation instructions.
- B. Install units with clearances for service and maintenance.
- C. Label units according to requirements specified in Division 23 Section "Mechanical Identification."

3.2 CONNECTIONS

- A. Duct installation and connection requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of ducts and duct accessories. Make final duct connections with flexible connectors. Flexible connectors are specified in Division 23 Section "Duct Accessories."

- B. Install ducts adjacent to power ventilators to allow service and maintenance.
- C. Ground equipment according to Division 26 Section "Grounding and Bonding."
- D. Connect wiring according to Division 26 Section "Conductors and Cables."

3.3 FIELD QUALITY CONTROL

- A. Perform the following field tests and inspections and prepare test reports:
 - 1. Verify that unit is secure on mountings and supporting devices and that connections to ducts and electrical components are complete. Verify that proper thermal-overload protection is installed in motors, starters, and disconnect switches.
 - 2. Disconnect fan drive from motor, verify proper motor rotation direction, and verify fan wheel free rotation and smooth bearing operation. Reconnect fan drive system, align and adjust belts, and install belt guards.
 - 3. Adjust belt tension.
 - 4. Adjust damper linkages for proper damper operation.
 - 5. Verify lubrication for bearings and other moving parts.
 - 6. Verify that dampers in connected ductwork systems are in fully open position.
 - 7. Disable automatic temperature-control operators, energize motor and adjust fan to indicated rpm, and measure and record motor voltage and amperage.
 - 8. Shut unit down and reconnect automatic temperature-control operators.
 - 9. Remove and replace malfunctioning units and retest as specified above.
- B. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

3.4 ADJUSTING

- A. Adjust damper linkages for proper damper operation.
- B. Adjust belt tension.
- C. Refer to Division 23 Section "Testing, Adjusting, and Balancing" for testing, adjusting, and balancing procedures.
- D. Replace fan and motor pulleys as required to achieve design airflow.
- E. Lubricate bearings.

3.5 DEMONSTRATION

- A. Train Owner's maintenance personnel to adjust, operate, and maintain power ventilators. Refer to Division 1 Sections.

END OF SECTION 233423

SECTION 233713 - DIFFUSERS, REGISTERS, GRILLES, AND LOUVERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes ceiling- and wall-mounted diffusers, registers, and grilles.
- B. This Section includes exterior wall-mounted louvers.
- C. Related Sections include the following:
 - 1. Division 7 Section "Joint Sealants" for sealants installed in perimeter joints between louver frames and adjoining construction.

1.3 SUBMITTALS

- A. Product Data: For each product indicated, include the following:
 - 1. Data Sheet: Indicate materials of construction, finish, and mounting details; and performance data including throw and drop, static-pressure drop, and noise ratings.
 - 2. Diffuser, Register, and Grille Schedule: Indicate Drawing designation, room location, quantity, model number, size, and accessories furnished.

1.4 QUALITY ASSURANCE

- A. Verification of Performance: Rate diffusers, registers, and grilles according to ASHRAE 70, "Method of Testing for Rating the Performance of Air Outlets and Inlets."
- B. SMACNA Standard: Comply with recommendations in SMACNA's "Architectural Sheet Metal Manual" for fabrication, construction, and installation of louvers.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 GRILLES AND REGISTERS

- A. Manufacturers
 - 1. Anemostat, a Mestek Company.
 - 2. Krueger.
 - 3. Price Industries.
 - 4. Titus.
 - 5. Tuttle and Bailey.

2.3 LOUVERS

- A. Manufacturers:
 - 1. American Warming and Ventilating, Inc.
 - 2. Arrow United Industries.
 - 3. Airolite Company.
 - 4. Greenheck.
 - 5. Ruskin Company.

2.4 FIXED, EXTRUDED-ALUMINUM LOUVERS

- A. Horizontal Drainable-Blade, Continuous Line, Louver:
 - 1. Louver Depth: 6-inches.
 - 2. Frame and Blade Nominal Thickness: As required to comply with structural performance requirements, but not less than .080-inches.
 - 3. Frame and Blade Material: Extruded aluminum, ASTM B221, alloy 6063-T5.
 - 4. Drainable-blades with blade gutters, and with semi recessed mullions capable of collecting and draining water from blades.
 - 5. Performance Requirements:
 - a. Free Area: Not less than 9.0 square feet for 48-inch wide by 48-inch high louver.
 - b. Air Performance: Not more than .07-inch wg static pressure drop at 700-fpm free-area velocity.
 - 6. AMCA Seal: Mark units with AMCA Certified Ratings Seal.

2.5 LOUVER SCREENS

- A. General: Provide screen at each exterior louver.
 - 1. Screen Location for Fixed Louvers: Interior face.
 - 2. Screening Type: Bird screening.
- B. Secure screens to louver frames with stainless-steel machine screws.
- B. Louver Screen Frames: Fabricate with mitered corners to louver sizes indicated.
 - 1. Metal: Same kind and form of metal as indicated for louver to which screens are attached. Reinforce extruded-aluminum screen frames at corners with clips.
- C. Louver Screening for Aluminum Louvers:
 - 1. Aluminum: 3/4-inch x 0.051-inch, birdscreen.

2.7 LOUVER FINISHES

- A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
- B. Finish louvers after assembly.
 - 1. Class I, Color Anodic Finish: AA-M12C22A42/A44 (Mechanical Finish: nonspecular as fabricated; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class I, integrally colored or electrolytically deposited color coating 0.018 mm or thicker) complying with AAMA 611. Color as selected by Architect from color charts.

PART 3 – EXECUTION

3.1 SCHEDULES

- A. See “Louvers and Air Grille Schedules” on the Plans for types utilized.

3.2 EXAMINATION

- A. Examine areas where diffusers, registers, and grilles are to be installed for compliance with requirements for installation tolerances and other conditions affecting performance of equipment. Correct unsatisfactory conditions.

3.3 INSTALLATION

- A. Install diffusers, registers, and grilles level and plumb.
- B. Ceiling-Mounted Outlets and Inlets: Drawings indicate general arrangement of ducts, fittings, and accessories. Air outlet and inlet locations have been indicated to achieve design requirements for air volume, noise criteria, airflow pattern, throw, and pressure drop. Make final locations where indicated, as much as practical. For units installed in lay-in ceiling panels, locate units in the center of panel. Where architectural features or other items conflict with installation, notify Architect for a determination of final location.
- C. Install diffusers, registers, and grilles with airtight connections to ducts.
- D. Locate and place louvers and vents level, plumb, and at indicated alignment with adjacent work.
- E. Use concealed anchorages where possible. Provide brass or lead washers fitted to screws where required to protect metal surfaces and to make a weathertight connection.
- F. Form closely fitted joints with exposed connections accurately located and secured.
- G. Provide perimeter reveals and openings of uniform width for sealants and joint fillers, as indicated.

3.4 ADJUSTING

- A. After installation, adjust diffusers, registers, and grilles to air patterns indicated.
- B. Test operation of adjustable louvers and adjust as needed to produce fully functioning units that comply with requirements.

3.5 CLEANING

- A. After installation, clean exposed surfaces to remove burrs, dirt, and smudges. Replace diffusers, registers, and grilles that have damaged finishes.
- B. Clean exposed surfaces of louvers and vents that are not protected by temporary covering, to remove fingerprints and soil during construction period. Do not let soil accumulate until final cleaning.
- C. Before final inspection, clean exposed surfaces with water and a mild soap or detergent not harmful to finishes. Thoroughly rinse surfaces and dry.
- D. Restore louvers and vents damaged during installation and construction so no evidence remains of corrective work. If results of restoration are unsuccessful, as determined by Architect, remove damaged units and replace with new units.
 - 1. Touch up minor abrasions in finishes with air-dried coating that matches color and gloss of, and is compatible with, factory-applied finish coating.

END OF SECTION 233713

SECTION 237400 - ROOFTOP AIR CONDITIONERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes the following rooftop air conditioners:
 - 1. Cooling and heating units 10 tons and smaller.

1.3 SUBMITTALS

- A. Product Data: Include manufacturer's technical data for each model indicated, including rated capacities, dimensions, required clearances, characteristics, furnished specialties, and accessories
- B. Operation and Maintenance Data: For rooftop air conditioners to include in emergency, operation, and maintenance manuals.
- C. Warranties: Special warranties specified in this Section.

1.4 QUALITY ASSURANCE

- A. Product Options: Drawings indicate size, profiles, and dimensional requirements of rooftop air conditioners and are based on the specific system indicated. Refer to Division 1 Section "Product Requirements."
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- C. Fabricate and label refrigeration system to comply with ASHRAE 15, "Safety Code for Mechanical Refrigeration."
- D. Energy-Efficiency Ratio: Equal to or greater than prescribed by ASHRAE 90.1, "Energy Efficient Design of New Buildings except Low-Rise Residential Buildings."
- E. Comply with NFPA 54 for gas-fired furnace section.
- F. ARI Certification: Units shall be ARI certified and listed.

1.5 COORDINATION

- A. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Division 7 Section "Roof Accessories."

1.6 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to replace components of rooftop air conditioners that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period for Compressors: Manufacturer's standard, but not less than five years from date of Substantial Completion.
 - 2. Warranty Period for Heat Exchangers: Manufacturer's standard, but not less than 10 years from date of Substantial Completion.

1.7 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Fan Belts: One set for each belt-drive fan.
 - 2. Filters: One set of filters for each unit.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. In other Part 2 articles where subparagraph titles below introduce lists, the following requirements apply for product selection:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by the manufacturers specified.

2.2 ROOFTOP AIR CONDITIONERS

- A. Manufacturers:
 - 1. AAON, Inc.
 - 2. Carrier Corp.
 - 3. Daiken-McQuay International.
 - 4. Trane Company (The); North American Commercial Group.
 - 5. YORK International Corporation.
- B. Description: Factory assembled and tested; designed for exterior installation; consisting of compressor, indoor and outside refrigerant coils, indoor fan and outside coil fan, refrigeration and temperature controls, gas-fired heat exchanger, filters, and dampers.
- C. Casing: Galvanized-steel construction with enamel paint finish, removable panels or access doors with neoprene gaskets for inspection and access to internal parts, minimum

1/2-inch-thick thermal insulation, knockouts for electrical and piping connections, exterior condensate drain connection, and lifting lugs.

- D. Indoor Fan: Forward curved, centrifugal, belt driven with adjustable motor sheaves, grease-lubricated ball bearings, and motor.
- E. Outside Coil Fan: Propeller type, directly driven by permanently lubricated motor.
- F. Refrigerant Coils: Aluminum-plate fin and seamless copper tube in steel casing with equalizing-type vertical distributor.
- G. Compressor(s): Number as scheduled hermetic reciprocating or scroll compressors with integral vibration isolators, internal overcurrent and overtemperature protection, internal pressure relief, and crankcase heater.
- H. Refrigeration System:
 - 1. Compressor(s).
 - 2. Outside coil and fan.
 - 3. Indoor coil and fan.
 - 4. Expansion valves with replaceable thermostatic elements.
 - 5. Refrigerant dryers.
 - 6. High-pressure switches.
 - 7. Low-pressure switches.
 - 8. Thermostats for coil freeze-up protection during low-ambient temperature operation or loss of air.
 - 9. Independent refrigerant circuits.
 - 10. Brass service valves installed in discharge and liquid lines.
 - 11. Charge of refrigerant.
 - 12. Timed Off Control: Automatic-reset control shuts compressor off after five minutes.
- I. Filters: 2-inch- thick, fiberglass, pleated, throwaway filters in filter rack.
- J. Heat Exchanger: Aluminized-steel construction with the following controls:
 - 1. Redundant dual gas valve with manual shutoff.
 - 2. Direct-spark pilot ignition.
 - 3. Electronic flame sensor.
 - 4. Induced-draft blower.
 - 5. Flame rollout switch.
- K. Power Connection: Provide for single connection of power to unit with unit-mounted disconnect switch accessible from outside unit and control-circuit transformer with built-in circuit breaker.
- L. Unit Controls: Solid-state control board and components contain at least the following features:
 - 1. door fan on/off delay.
 - 2. Default control to ensure proper operation after power interruption.
 - 3. Service relay output.
 - 4. Unit diagnostics and diagnostic code storage.

5. Field-adjustable control parameters.
 6. Defrost control.
 7. Gas valve delay between first- and second-stage firing.
 8. Low-ambient control, allowing operation down to 0 deg F.
 9. Minimum run time.
 10. Smoke alarm with smoke detector installed in return air as scheduled on the Plans.
 11. Low-refrigerant pressure control.
 12. Digital display of outside temperature, supply-air temperature, return-air temperature, economizer damper position, and control parameters.
- M. Thermostat (where specified for single zone applications): Programmable, electronic; with heating setback and cooling setup with seven-day programming; and the following:
1. Touch sensitive keyboard.
 2. Automatic switching.
 3. Deg F readout.
 4. LED indicators.
 5. Hour/day programming.
 6. Manual override capability.
 7. Time and operational mode readout.
 8. Status indicator.
 9. Battery backup.
 10. Subbase with manual system switch (on-heat-auto-cool) and fan switch (auto-on).
 11. Fan-proving switch to lock out unit if fan fails.
 12. Dirty-filter switch.
- N. Variable-volume variable-temperature (VVT) controls, where specified for multiple zone applications. See "HVAC Equipment Schedules" on the Plans.
- O. Roof Curb: Steel with corrosion-protection coating, gasketing, and factory-installed wood nailer; complying with NRCA standards; minimum height of 14 inches.
- P. Additional Accessories: See "Mechanical Equipment Schedules" on the plans for additional accessories unique for each unit.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install units level and plumb, maintaining manufacturer's recommended clearances. Install according to ARI Guideline B.
- B. Curb Support: Install roof curb on roof structure, level and secure, according to NRCA's "Low-Slope Membrane Roofing Construction Details Manual," Illustration "Raised Curb Detail for Rooftop Air Handling Units and Ducts." Install and secure rooftop air conditioners on curbs and coordinate roof penetrations and flashing with roof construction.

- C. Isolation Curb Support: Install units on isolation curbs according to NRCA's "Low-Slope Membrane Roofing Construction Details Manual," Illustration "Raised Curb Detail for Rooftop Air Handling Units and Ducts."

3.2 CONNECTIONS

- A. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to machine to allow service and maintenance.
 - 1. Gas Piping: Comply with applicable requirements in Division 23 Section "Liquified Petroleum Gas Piping." Connect gas piping to burner, full size of gas train inlet, and connect with union and shutoff valve with sufficient clearance for burner removal and service.
- C. Duct installation requirements are specified in other Division 23 Sections. Drawings indicate the general arrangement of ducts. The following are specific connection requirements:
 - 1. Install ducts to termination in roof curb.
 - 2. Remove roof decking only as required for passage of ducts. Do not cut out decking under entire roof curb.
 - 3. Connect supply ducts to rooftop unit with flexible duct connectors specified in Division 23 Section "Duct Accessories."
 - 4. Insulate all spaces between roof and bottom of unit with 12-inch thick fiberglass blanket insulation for noise reduction.
- D. Electrical System Connections: Comply with applicable requirements in Division 26 Sections for power wiring, switches, and motor controls.
- E. Temperature control wiring: Provide wiring in conduits, in accordance with Division 26 Sections.
- F. Ground equipment according to Division 26 Section "Grounding and Bonding."
- G. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.3 STARTUP SERVICE

- A. Complete installation and startup checks according to manufacturer's written instructions and do the following:
 - 1. Inspect for visible damage to unit casing.
 - 2. Inspect for visible damage to furnace combustion chamber.
 - 3. Inspect for visible damage to compressor, air-cooled outside coil, and fans.
 - 4. Inspect internal insulation.
 - 5. Verify that labels are clearly visible.
 - 6. Verify that clearances have been provided for servicing.
 - 7. Verify that controls are connected and operable.

8. Verify that filters are installed.
9. Clean outside coil and inspect for construction debris.
10. Clean furnace flue and inspect for construction debris.
11. Connect and purge gas line.
12. Adjust vibration isolators.
13. Inspect operation of barometric dampers.
14. Lubricate bearings on fan.
15. Inspect fan-wheel rotation for movement in correct direction without vibration and binding.
16. Adjust fan belts to proper alignment and tension.
17. Start unit according to manufacturer's written instructions.
18. Inspect and record performance of interlocks and protective devices; verify sequences.
19. Operate unit for an initial period as recommended or required by manufacturer.
20. Perform for both minimum and maximum firing and adjust burner for peak efficiency. Adjust pilot to stable flame.
21. Calibrate thermostats.
22. Adjust and inspect high-temperature limits.
23. Inspect outside-air dampers for proper stroke and interlock with return-air dampers.
24. Inspect controls for correct sequencing of heating, mixing dampers, refrigeration, and normal and emergency shutdown.
25. Verify operation of remote panel, including pilot-light operation and failure modes. Inspect the following:
 - a. High-limit heat exchanger.
 - b. Freezestat operation.
 - c. Economizer to limited outside-air changeover.
 - d. Alarms.
26. After startup and performance testing, change filters, vacuum heat exchanger and cooling and outside coils, lubricate bearings, adjust belt tension, and inspect operation of power vents.

3.4 ADJUSTING

- A. Adjust initial temperature set points.
- B. Set field-adjustable switches and circuit-breaker trip ranges as indicated.
- C. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to site outside normal occupancy hours for this purpose, without additional cost.

3.5 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain rooftop air conditioners. Refer to Division 1 Section "Closeout Procedures."

END OF SECTION 237400

SECTION 237423 - DIRECT-FIRED MAKE-UP AIR UNITS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes direct-fired make-up air units (MAU).

1.3 SUBMITTALS

- A. Product Data: Include rated capacities, furnished specialties, and accessories.
- B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 1. Mounting Details: Detail fabrication including anchorages and attachments to structure and to supported equipment.
 - 2. Wiring Diagrams: Power, signal, and control wiring.
- C. Startup service reports.
- D. Operation and Maintenance Data: For direct-fired make-up air units to include in emergency, operation, and maintenance manuals.

1.4 QUALITY ASSURANCE

- A. Product Options: Drawings indicate size, profiles, and dimensional requirements of direct-fired make-up air units and are based on the specific system indicated. Refer to Division 1 Section "Product Requirements."
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- C. Comply with the International Fuel Gas Code, and NFPA 70.
- D. Entire unit shall be ETL Certified per ANSI Z83.4 or Z83.18 and bear on ETL mark.

1.5 COORDINATION

- A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 3.

1.6 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Filters: One set for each unit.
 - 2. Fan Belts: One set for each unit.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Absolut Aire.
 - 2. Engineered Air.
 - 3. Greenheck Fan Corporation.

2.2 PACKAGED UNITS

- A. Factory-assembled, prewired, self-contained unit consisting of cabinet, outdoor air intake weather hood, supply fan, controls, filters, and direct-fired gas burner. See plans for locations of interior and exterior units.

2.3 CABINET

- A. Cabinet: Double-wall 18 gauge galvanized-steel panels, formed to ensure rigidity and supported by galvanized-steel channels or structural channel supports with lifting lugs. All sections shall be insulated, and be provided with 24-gauge solid galvanized steel liner.
- B. Access Panels: Piano hinged for furnace, filters, damper, access sections, control panels and fan motor assemblies.
- C. Internal Insulation: Fibrous-glass duct lining, comply with ASTM C 1071, Type II;
 - 1. Thickness: 1-inch.
 - 2. Insulation Adhesive: Comply with ASTM C 916, Type I.
 - 3. Mechanical Fasteners: Galvanized steel suitable for adhesive attachment, mechanical attachment, or welding attachment to casing without damaging liner when applied as recommended by manufacturer and without causing air leakage.
 - 4. Locations: Fan sections, heat sections.
- D. Finish: Heat-resistant, polyester based powder resin, or air dry industrial enamel, all sections and accessories.

E. Discharge: See plans and HVAC Equipment Schedules.

2.4 SUPPLY-AIR FAN

- A. Fan Type: Centrifugal, rated according to AMCA 210; statically and dynamically balanced, galvanized steel; mounted on solid-steel shaft with heavy-duty, pillow-block bearings rated for L50 or 200,000 hours with external grease fittings.
- B. Motor: Premium efficiency, totally enclosed.
- C. Drive: V-belt drive with matching fan pulley and adjustable motor sheaves and belt assembly. Direct drive arrangement acceptable when specified (See HVAC Equipment Schedules on the Plans).
- D. Variable Frequency Drive: When specified (See HVAC Equipment Schedules on the Plans).
- E. Mounting: Fan wheel, motor, and drives shall be mounted in fan casing with neoprene isolators.

2.5 AIR FILTERS

- A. Comply with NFPA 90A. See Plans for filter type and sections at each unit.
- B. Disposable Panel Filters: 2-inch thick, factory-fabricated, pleated-panel-type Merv-13, disposable air filters with holding frames.
 - 1. Media: Interlaced non-woven and synthetic fibric media.
 - 2. Frame: Galvanized steel.

2.6 OUTDOOR-AIR INTAKE HOOD

- A. Type: Manufacturer's standard hood, with materials to match cabinet, designed to inhibit wind-driven rain and snow from entering unit.
- B. Aluminum Mesh: Manufacturer's mesh, to comply with ASHRAE 62.1.

2.7 ROOF CURBS

- A. Roof Curbs: Galvanized steel with corrosion-protection coating, watertight gaskets, and factory-installed wood nailer; with a height of 18-inches minimum, complying with NRCA standards. Roof curbs shall be 12-inches minimum height for units installed at grade and concrete foundations.
 - 1. Curb Insulation and Adhesive: Comply with NFPA 90A or NFPA 90B.
 - a. Materials: ASTM C 1071, Type I or Type II.
 - b. Thickness: 1-1/2 inches.

2.8 DIRECT-FIRED GAS FURNACE

- A. Description: Factory assembled, piped, and wired; and complying with ANSI Z83.4, "Direct Gas-Fired Make-Up Air Heaters"; ANSI Z83.18, "Direct Gas-Fired Industrial Air Heaters"; and the "International Fuel Gas Code."
- B. Controls: Electronic, modulation burner control.
- C. Burners: Aluminum or cast-iron burner with stainless-steel mixing plates.
 - 1. Control Valve: Electronic modulating with minimum turndown ratio of 30:1.
 - 2. Fuel: Liquified Petroleum (LP) gas.
 - 3. Pilot: Electrically ignited by hot-surface ceramic igniter.
- D. Safety Controls:
 - 1. Gas Manifold: Safety switches and controls to comply with ANSI standards and FM Global requirements.
 - 2. Purge-Period Timer: Automatically delays burner ignition and bypasses low-limit control.
 - 3. Airflow Proving Switch: Dual pressure switch senses correct airflow before energizing pilot and requires airflow to be maintained within minimum and maximum pressure settings across burner.
 - 4. Manual-Reset, High-Limit Control Device: Stops burner and closes main gas valve if high-limit temperature is exceeded.
 - 5. Manual-reset, low-limit control device: Stops fan and burner, closes gas valve if low-limit temperature is reached.
 - 6. Gas Train: Redundant, automatic main gas valves, electric pilot valve, electronic-modulating temperature control valve, main and pilot gas regulators, main and pilot manual shutoff valves, main and pilot pressure taps, and high-low gas pressure switches
 - 7. Safety Lockout Switch: Locks out ignition sequence if burner fails to light after three tries. Controls are reset manually by turning the unit off and on.
 - 8. Control Transformer: Integrally mounted 24-V ac.

2.9 CONTROLS

- A. Factory-wired, fuse-protected control transformer, connection for power supply and field-wired unit to remote control panel.
- B. Unit control center shall include an integral exhaust fan starter. Starter shall be factory-mounted and wired for an electrical interlock between the supply fan and exhaust fan. Different means for electrical interlock shall be acceptable when specified elsewhere.
- C. Control Panel: Surface-mounted remote panel, Nema 4X, with engraved plastic cover, and the following lights and switches:
 - 1. Summer-Off-Winter switch.
 - 2. Supply-fan operation indicating light.
 - 3. Exhaust-fan operation indicating light.

4. Heating operation indicating light.
5. Dirty-filter indicating light operated by unit-mounted differential pressure switch.
6. Safety-lockout, flame failure (general alarm) indicating light.
7. Room override thermostat.

D. Control Devices:

1. Adjustable discharge air temperature controls unit mounted, with adjustable room override thermostat, located in the conditioned space.

E. Fan Control: The fan is intended to operate continuously 24 hours/day, 365 days/year, to provide the required air changes per hour, per NFPA 820 and the Ten States Standards. The make-up air unit shall be interlocked to operate with the exhaust fan. The make-up supply fan shall contain air flow switches, starter current sensing relays, or other means to prove fan operation. The make-up air fan shall not be permitted to operate until operation of the exhaust fan is proven. If the exhaust fan is not operating, the make-up air shall not be permitted to operate.

F. CAPACITIES, CHARACTERISTICS, AND ADDITIONAL ACCESSORIES

1. See "Mechanical Equipment Schedule" on the Plans.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting installation of direct-fired make-up air units.
- B. Examine roughing-in for piping, ducts, and electrical systems to verify actual locations of connections before equipment installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install gas-fired units according to the "International Fuel Gas Code."
- B. Install makeup air units on cast-in-place concrete equipment bases. Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete", and as detailed on the plans.
- C. Roof Curb: Install on roof structure or concrete base, level and secure, according to NRCA's "Low-Slope Membrane Roofing Construction Details Manual," Illustration "Raised Curb Detail for Rooftop Air Handling Units and Ducts". Install units on curbs and coordinate roof penetrations and flashing with roof construction specified. Secure units to upper curb rail, and secure curb base to roof framing with anchor bolts.

- D. Install controls and equipment shipped by manufacturer for field installation with direct-fired make-up air units.

3.3 CONNECTIONS

- A. Piping Connections: Drawings indicate general arrangement of piping, fittings, and specialties. Install piping adjacent to machine to allow service and maintenance.
 - 1. Gas Piping: Comply with requirements in Division 23 Section "Liquified-Petroleum Gas Piping." Connect gas piping with shutoff valve and union and with sufficient clearance for burner removal and service. Provide AGA-approved flexible connectors if required by manufacturer.
- B. Duct Connections: Duct installation requirements are specified in Division 23 Section "Metal Ducts." Drawings indicate the general arrangement of ducts. Connect supply and outside air ducts to direct-fired make-up air units with flexible duct connectors. Flexible duct connectors are specified in Division 23 Section "Duct Accessories."
- C. Ground equipment according to Division 26 Section "Grounding and Bonding."
- D. Provide control wiring between unit panel and remote control panel, according to Division 26 Section "Conductors and Cables."

3.4 STARTUP SERVICE

- A. Engage a factory-authorized service representative to perform startup service. Complete installation and startup checks according to manufacturer's written instructions and perform the following:
 - 1. Inspect for visible damage and integrity for all sections.
 - 2. Verify that controls are connected and operable.
 - 3. Verify that filters are installed.
 - 4. Purge gas line.
 - 5. Verify bearing lubrication.
 - 6. Inspect fan-wheel rotation for movement in correct direction without vibration and binding.
 - 7. Adjust fan belts to proper alignment and tension.
 - 8. Start unit according to manufacturer's written instructions.
 - 9. Complete startup sheets and attach copy with Contractor's startup report.
 - 10. Inspect and record performance of interlocks and protective devices; verify sequences.
 - 11. Operate unit for run-in period recommended by manufacturer.
 - 12. Perform all operations for both minimum and maximum firing and adjust burner for peak efficiency. Measure gas pressure on manifold. Measure combustion-air temperature at inlet to combustion chamber. Measure supply-air temperature and volume when burner is at maximum firing rate and when burner is off. Calculate useful heat to supply air.
 - 13. Calibrate thermostats.
 - 14. Adjust and inspect high-temperature limits.

15. Inspect dampers, if any, for proper stroke and interlock with return-air dampers.
 16. Inspect controls for correct sequencing of heating and normal and emergency shutdown.
 17. Measure and record airflow.
 18. Verify operation of remote panel, including pilot-operation and failure modes. Inspect high-limit heat and all alarms.
 19. After startup and performance testing, change filters, verify bearing lubrication, and adjust belt tension.
- B. Remove and replace malfunctioning components that do not pass tests and inspections and retest as specified above.
- C. Prepare written report of the results of startup services.

3.5 ADJUSTING

- A. Adjust initial temperature set points. Set field-adjustable switches and circuit-breaker trip ranges as indicated.
- B. Working Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project.

3.6 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain direct-fired make-up air units. Refer to Division 1 Sections.

END OF SECTION 237423

SECTION 237425 - INDIRECT-FIRED MAKE-UP AIR UNITS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes indirect-fired make-up air units (MAU).

1.3 SUBMITTALS

- A. Product Data: Include rated capacities, furnished specialties, and accessories.
- B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 1. Mounting Details: Detail fabrication including anchorages and attachments to structure and to supported equipment.
 - 2. Wiring Diagrams: Power, signal, and control wiring.
- C. Startup service reports.
- D. Operation and Maintenance Data: For direct-fired make-up air units to include in emergency, operation, and maintenance manuals.

1.4 QUALITY ASSURANCE

- A. Product Options: Drawings indicate size, profiles, and dimensional requirements of direct-fired make-up air units and are based on the specific system indicated. Refer to Division 1 Section "Product Requirements."
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- C. Comply with the International Fuel Gas Code, and NFPA 70.
- D. Indirect gas-fired heaters shall be ETL Certified as a component of the unit, to ANSI Standard and CSA 2.6.
- E. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."

1.5 COORDINATION

- A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 3.

1.6 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Filters: One set for each unit.
 - 2. Fan Belts: One set for each unit.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Absolut Aire.
 - 2. Engineered Air.
 - 3. Greenheck Fan Corporation.

2.2 PACKAGED UNITS

- A. Factory-assembled, prewired, self-contained unit consisting of cabinet, outdoor air intake weather hood, supply fan, controls, filters, heat exchangers and indirect-fired gas burner. See plans for locations of interior and exterior units.

2.3 CABINET

- A. Cabinet: Double-wall 18 gauge galvanized-steel panels, formed to ensure rigidity and supported by galvanized-steel channels or structural channel supports with lifting lugs. All sections shall be insulated, and be provided with 24-gauge solid or perforated galvanized steel liner.
- B. Access Panels: Piano hinged for furnace, filters, damper, access sections, control panels and fan motor assemblies.
- C. Internal Insulation: Fibrous-glass duct lining, comply with ASTM C 1071, Type II;
 - 1. Thickness: 1-inch.
 - 2. Insulation Adhesive: Comply with ASTM C 916, Type I.
 - 3. Mechanical Fasteners: Galvanized steel suitable for adhesive attachment, mechanical attachment, or welding attachment to casing without damaging liner when applied as recommended by manufacturer and without causing air leakage.

4. Locations: Fan sections, heat sections.
- D. Finish: Heat-resistant, polyester based powder resin, or air dry industrial enamel, all sections and accessories.
- E. Discharge: See plans and HVAC Equipment Schedules.
- F. Roof Curbs: Galvanized steel with corrosion-protection coating, watertight gaskets, and factory-installed wood nailer; with a height of 18-inches minimum, complying with NRCA standards. Roof curbs shall be 12-inches minimum height for units installed at grade and concrete foundations.
 1. Curb Insulation and Adhesive: Comply with NFPA 90A or NFPA 90B.
 - a. Materials: ASTM C 1071, Type I or Type II.
 - b. Thickness: 1-1/2 inches.

2.4 SUPPLY-AIR FAN

- A. Fan Type: Centrifugal, rated according to AMCA 210; statically and dynamically balanced, galvanized steel; mounted on solid-steel shaft with heavy-duty, pillow-block bearings rated for L50 or 200,000 hours with external grease fittings.
- B. Motor: Premium efficiency, totally enclosed.
- C. Drive: V-belt drive with matching fan pulley and adjustable motor sheaves and belt assembly. Direct drive arrangement acceptable when specified (See HVAC Equipment Schedules on the Plans).
- D. Variable Frequency Drive: When specified (See HVAC Equipment Schedules on the Plans).
- E. Mounting: Fan wheel, motor, and drives shall be mounted in fan casing with neoprene isolators.

2.5 AIR FILTERS

- A. Comply with NFPA 90A. See Plans for filter type and sections at each unit.
- B. Disposable Panel Filters: 2-inch thick, factory-fabricated, pleated-panel-type Merv-13, disposable air filters with holding frames.
 1. Media: Interlaced non-woven and synthetic fibric media.
 2. Frame: Galvanized steel.

2.6 OUTDOOR-AIR INTAKE HOOD

- A. Type: Manufacturer's standard hood, with materials to match cabinet, designed to inhibit wind-driven rain and snow from entering unit.

- B. Aluminum Mesh: Manufacturer's mesh, to comply with ASHRAE 62.1.

2.7 INDIRECT-FIRED GAS BURNER

- A. Description: Factory assembled, piped, and wired; and complying with ANSI Z21.47, "Gas-Fired Central Furnaces," and with NFPA 54, "National Fuel Gas Code."
 - 1. CSA Approval: Designed and certified by and bearing label of CSA.
 - 2. Burners: Stainless steel.
 - a. Gas Control Valve: 4:1 Modulating.
 - b. Fuel: Propane gas.
 - c. Minimum Combustion Efficiency: 80 percent.
 - d. Ignition: Electronically controlled electric spark with flame sensor.
- B. Venting: Power vented, with integral, motorized centrifugal fan interlocked with gas valve.
- C. Heat Exchanger: Constructed of type 409 stainless steel. Heat exchangers shall be shell and tube type design, with 4-pass tubular heat exchangers. Heat exchanger tubes shall be installed on the vest plate by means of a swaged assembly. Heat exchanger tubes shall be supported by a minimum of two fabricated assemblies that support the tubes and also permit expansion and contraction of the tubes.
- D. Heat-Exchanger Drain Pan: Stainless steel.
- E. Safety Controls:
 - 1. Vent Flow Verification: Differential pressure switch to verify open vent.
 - 2. Control Transformer: 24-V ac.
 - 3. High Limit: Thermal switch or fuse to stop burner.
 - 4. Gas Train: Regulated, redundant, 24-V ac gas valve assembly containing pilot solenoid valve, electronic-modulating temperature control valve, pilot filter, pressure regulator, pilot shutoff, and manual shutoff all in one body.
 - 5. Purge-period timer shall automatically delay burner ignition and bypass low-limit control.
 - 6. Gas Manifold: Safety switches and controls complying with ANSI standards and FM Global.
 - 7. Airflow Proving Switch: Differential pressure switch senses correct airflow before energizing pilot.
 - 8. Automatic-Reset, High-Limit Control Device: Stops burner and closes main gas valve if high-limit temperature is exceeded.
 - 9. Safety Lockout Switch: Locks out ignition sequence if burner fails to light after three tries. Controls are reset manually by turning the unit off and on.

2.8 CONTROLS

- A. Factory-wired, fuse-protected control transformer, connection for power supply and field-wired unit to remote control panel.

- B. Control Panel: Surface-mounted remote panel, Nema 4X, with engraved plastic cover, and the following lights and switches:
 - 1. Summer-Off-Winter switch.
 - 2. Supply-fan operation indicating light.
 - 3. Heating operation indicating light.
 - 4. Dirty-filter indicating light operated by unit-mounted differential pressure switch.
 - 5. Safety-lockout, flame failure (general alarm) indicating light.

- C. Control Devices:
 - 1. Adjustable discharge air temperature controls unit mounted.

- F. Fan Control: The fan is intended to operate continuously 24 hours/day, 365 days/year, to provide the required air changes per hour, per NFPA 820 and the Ten States Standards. The make-up supply fan shall contain air flow switches, starter current sensing relays, or other means to prove fan operation.

- G. CAPACITIES, CHARACTERISTICS, AND ADDITIONAL ACCESSORIES
 - 1. See "Mechanical Equipment Schedule" on the Plans.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting installation of direct-fired make-up air units.
- B. Examine roughing-in for piping, ducts, and electrical systems to verify actual locations of connections before equipment installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install gas-fired units according to the "International Fuel Gas Code."
- B. Install makeup air units on cast-in-place concrete equipment bases. Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete", and as detailed on the plans.
- C. Roof Curb: Install on roof structure or concrete base, level and secure, according to NRCA's "Low-Slope Membrane Roofing Construction Details Manual," Illustration "Raised Curb Detail for Rooftop Air Handling Units and Ducts". Install units on curbs and coordinate roof penetrations and flashing with roof construction specified. Secure units to upper curb rail, and secure curb base to roof framing with anchor bolts.

- D. Install controls and equipment shipped by manufacturer for field installation with direct-fired make-up air units.

3.3 CONNECTIONS

- A. Piping Connections: Drawings indicate general arrangement of piping, fittings, and specialties. Install piping adjacent to machine to allow service and maintenance.
 - 1. Gas Piping: Comply with requirements in Division 23 Section "Liquified-Petroleum Gas Piping." Connect gas piping with shutoff valve and union and with sufficient clearance for burner removal and service. Provide AGA-approved flexible connectors if required by manufacturer.
- B. Duct Connections: Duct installation requirements are specified in Division 23 Section "Metal Ducts." Drawings indicate the general arrangement of ducts. Connect supply and outside air ducts to direct-fired make-up air units with flexible duct connectors. Flexible duct connectors are specified in Division 23 Section "Duct Accessories."
- C. Ground equipment according to Division 26 Section "Grounding and Bonding."
- D. Provide control wiring between unit panel and remote control panel, according to Division 26 Section "Conductors and Cables."

3.4 STARTUP SERVICE

- A. Engage a factory-authorized service representative to perform startup service. Complete installation and startup checks according to manufacturer's written instructions and perform the following:
 - 1. Inspect for visible damage and integrity for all sections.
 - 2. Verify that controls are connected and operable.
 - 3. Verify that filters are installed.
 - 4. Purge gas line.
 - 5. Verify bearing lubrication.
 - 6. Inspect fan-wheel rotation for movement in correct direction without vibration and binding.
 - 7. Adjust fan belts to proper alignment and tension.
 - 8. Start unit according to manufacturer's written instructions.
 - 9. Complete startup sheets and attach copy with Contractor's startup report.
 - 10. Inspect and record performance of interlocks and protective devices; verify sequences.
 - 11. Operate unit for run-in period recommended by manufacturer.
 - 12. Perform all operations for both minimum and maximum firing and adjust burner for peak efficiency. Measure gas pressure on manifold. Measure combustion-air temperature at inlet to combustion chamber. Measure supply-air temperature and volume when burner is at maximum firing rate and when burner is off. Calculate useful heat to supply air.
 - 13. Calibrate thermostats.
 - 14. Adjust and inspect high-temperature limits.

15. Inspect dampers, if any, for proper stroke and interlock with return-air dampers.
 16. Inspect controls for correct sequencing of heating and normal and emergency shutdown.
 17. Measure and record airflow.
 18. Verify operation of remote panel, including pilot-operation and failure modes. Inspect high-limit heat and all alarms.
 19. After startup and performance testing, change filters, verify bearing lubrication, and adjust belt tension.
- B. Remove and replace malfunctioning components that do not pass tests and inspections and retest as specified above.
- C. Prepare written report of the results of startup services.

3.5 ADJUSTING

- A. Adjust initial temperature set points. Set field-adjustable switches and circuit-breaker trip ranges as indicated.
- B. Working Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project.

3.6 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain direct-fired make-up air units. Refer to Division 1 Sections.

END OF SECTION 237423

SECTION 238126 - SPLIT-SYSTEM AIR-CONDITIONING UNITS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes split-system air-conditioning units consisting of separate evaporator-fan and compressor-condenser components. Units are designed for exposed or concealed mounting, and may be connected to ducts.

1.3 SUBMITTALS

- A. Product Data: Include rated capacities, furnished specialties, and accessories for each type of product indicated. Include performance data in terms of capacities, outlet velocities, static pressures, sound power characteristics, motor requirements, and electrical characteristics.
- B. Shop Drawings: Diagram power, signal, and control wiring.
- C. Field quality-control test reports.
- D. Operation and Maintenance Data: For split-system air-conditioning units to include in emergency, operation, and maintenance manuals.
- E. Warranty: Special warranty specified in this Section.

1.4 QUALITY ASSURANCE

- A. Product Options: Drawings indicate size, profiles, and dimensional requirements of split-system units and are based on the specific system indicated. Refer to Division 1 Section "Product Requirements."
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- C. Energy-Efficiency Ratio: Equal to or greater than prescribed by ASHRAE 90.1, "Energy Efficient Design of New Buildings except Low-Rise Residential Buildings."

1.5 COORDINATION

- A. Coordinate size and location of concrete bases for units. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork are specified in Division 3 Section "Cast-in-Place Concrete."

1.6 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of split-system air-conditioning units that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period: Five years for compressor from date of Substantial Completion, one year on remaining components.

1.7 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Filters: One set of filters for each unit.
 - 2. Fan Belts: One set of belts for each unit.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Carrier Air Conditioning; Div. of Carrier Corporation.
 - 2. Mitsubishi Electronics America, Inc.; HVAC Division.
 - 3. Sanyo Fisher (U.S.A.) Corp.
 - 4. Trane Company (The); Unitary Products Group.
 - 5. York International Corp.

2.2 EVAPORATOR-FAN COMPONENTS

- A. General: Evaporator-fan unit shall be completely factory assembled including coil, condensate drain pan, fan, motor, filters, and controls in a casing.
- B. Cabinet, High-wall type: Polystyrene, with a baked enamel or polyester powder coating, with removable panels on front and ends, with drain connection.
- C. Cabinet, Ceiling mounted cassette type: steel cabinet, with enamel coated steel combination supply-air and return-air discharge grille.
- D. Insulation: Cabinet to be completed insulated with cleanable, foil-faced, fire-retardent, fiberglass insulation.

- E. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins, complying with ARI 210/240, and with thermal-expansion valve. See plans and equipment schedules for refrigerant circuit quantities (single, dual, etc.).
- F. Fan: Forward curve, centrifugal fan. Direct drive for nominal 4 tons and below. Belt drive, adjustable for nominal 5 tons and above.
- G. Fan Motors: Multitapped, multispeed for nominal 4 tons and below. Single speed for nominal 5 tons and above. All to have internal thermal protection and permanent lubrication.
- H. Filters: Permanent, cleanable, or 2-inch thick pleated throwaway type as indicated on the plans and equipment schedules.

2.3 AIR-COOLED, COMPRESSOR-CONDENSER COMPONENTS

- A. Casing: Galvanized steel, finished with baked enamel or polyester powder, with removable panels for access to controls, weep holes for water drainage, and mounting holes in base. Provide brass service valves, fittings, and gage ports on exterior of casing.
- B. Compressor(s): Hermetically sealed with crankcase heater and mounted on vibration isolation. Compressor motor shall have thermal- and current-sensitive overload devices, start capacitor, relay, and contactor.
 - 1. Compressor Type: Reciprocating or Scroll.
 - 2. Manual-reset high-pressure switch and automatic-reset low-pressure switch.
 - 3. Refrigerant Charge: R-410A.
 - 4. Compressor Quantities: See plans and equipment schedules for compressor quantities, as related to single or dual circuits.
- C. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins, complying with ARI 210/240, and with liquid subcooler.
- D. Fan: Aluminum-propeller type, directly connected to motor.
- E. Motor: Permanently lubricated, with integral thermal-overload protection.
- F. Low Ambient Operation: Permits operation down to -22 deg F.
- G. Mounting: Equipment supports for rooftop applications, and concrete base for grade applications.

2.4 ACCESSORIES

- A. Thermostat: Low voltage with subbase to control compressor and evaporator fan.
 - 1. Compressor time delay.
 - 2. 24-hour time control of system stop and start.
 - 3. Liquid-crystal display indicating temperature, set-point temperature, time setting, operating mode, and fan speed.
 - 4. Fan-speed selection, including auto setting.

- B. Automatic-reset timer to prevent rapid cycling of compressor.
- C. Refrigerant Line Kits: Soft-annealed copper suction and liquid lines factory cleaned, dried, pressurized, and sealed; factory-insulated suction line with flared fittings at both ends.
- D. See equipment schedules on the plans for additional accessories unique for each piece of equipment.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install units level and plumb.
- B. Install evaporator-fan components using manufacturer's standard mounting devices securely fastened to building structure.
- C. Install roof-mounted, compressor-condenser components on equipment supports. Anchor units to supports with removable, cadmium-plated fasteners.
- D. Install ground-mounting, compressor-condenser components on 6-inch-thick, reinforced concrete base; 4 inches larger on each side than unit. Concrete, reinforcement, and formwork are specified in Division 3 Section "Cast-in-Place Concrete." Coordinate anchor installation with concrete base.
- E. Install and connect precharged refrigerant tubing to component's quick-connect fittings. Install tubing to allow access to unit.

3.2 CONNECTIONS

- A. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to unit to allow service and maintenance.
- C. Ground equipment according to Division 26 Section "Grounding and Bonding."
- D. Electrical Connections: Comply with requirements in Division 26 Sections for power wiring, switches, and motor controls.
- E. Provide control wiring, conduits in accordance with Division 26 Sections.

3.3 FIELD QUALITY CONTROL

- A. Perform the following field tests and inspections and prepare test reports:
 - 1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.

2. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

3.4 STARTUP SERVICE AND DEMONSTRATION

- A. Train Owner's maintenance personnel to adjust, operate, and maintain units. Refer to Division 1 for Closeout Procedures.
- B. Operational Demonstration shall be per Division 1 Sections.
- C. Instruction of the Owner's Personnel shall be per Division 1 Sections.

END OF SECTION 238126

SECTION 238339 - ELECTRIC HEATERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes electric unit heaters and wall heaters.

1.3 SUBMITTALS

- A. Product Data: Include specialties and accessories for each unit type and configuration.
- B. Maintenance Data: For heaters to include in maintenance manuals specified in Division 1. Include the following:
 - 1. Maintenance schedules and repair parts lists for motors, coils, integral controls, and filters.

1.4 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. ASHRAE/IESNA 90.1 Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."

1.5 COORDINATION

- A. Coordinate layout and installation of heaters and suspension system components with other construction including light fixtures, HVAC equipment, fire-suppression-system components, and partition assemblies.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Berko, Division of Marley Products.
 - 2. Markel Products Co.
 - 3. Chromalox, Inc.
 - 4. Electromode.

5. Indeeco.

2.2 ELECTRIC HEATERS

- A. Description: An assembly including casing, heating element, fan, and motor in blow-through configuration.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- C. Comply with UL 2021.
- D. Comply with UL 823.

2.3 MATERIALS

- A. Cabinet, Unit Heaters: 18 gauge welded steel cabinet with powder coated finish, and control compartment housing a terminal board with a hinged and latched access door.
- A. Cabinet, Wall Heaters: 18 gauge steel housing with powder coated 18 gauge steel grille, with extruded aluminum front frame.

2.4 ELECTRIC-RESISTANCE HEATING ELEMENTS

- A. Unit Heaters: copper clad steel sheath element with continuously brazed steel fins formed to allow side draw through airflow. Overheat protection shall be automatic reset type limit controls to de-energize the heater should over-temperature occur.
- B. Wall Heaters: steel block fin element. Heating element shall be of the sealed tubular type with parallel steel fins for quick heat transfer. Unit shall have a thermal overload cut-off, and automatic reset thermal limit.

2.5 FAN AND MOTORS

- A. Unit Heaters: Propeller type fan with aluminum wheel directly mounted on motor shaft in the fan venturi. Individual adjustable horizontal louvers for directional control. Motor is totally enclosed, 1-speed, permanently lubricated, thermally protected.
- B. Wall Heaters: vane axial type. Motor is low speed, 4-pole, permanently lubricated, thermally protected.

2.6 ACCESSORIES AND CONTROLS

- A. See "Equipment Schedules" on the Plans.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas to receive heaters for compliance with requirements for installation tolerances and other conditions affecting performance.
- B. Examine roughing-in for electrical connections to verify actual locations before heater installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install heaters level and plumb.
- B. Install heaters to comply with NFPA 90A.
- C. Suspend heaters from structure with manufacturer's mounting brackets.
- D. Install wall-mounting thermostats and switch controls in electrical outlet boxes at heights to match lighting controls.

3.3 CONNECTIONS

- A. See Division 26 Sections for grounding of equipment and power wiring.
- B. Provide temperature control wiring in accordance with Division 26 Sections.
- C. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.4 FIELD QUALITY CONTROL

- A. Testing: Perform the following field quality-control testing and report results in writing:
 - 1. After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
 - 2. Operate electric heating elements through each stage to verify proper operation and electrical connections.
 - 3. Test and adjust controls and safeties.
- B. Repair or replace malfunctioning units. Retest as specified above after repairs or replacements are made.

3.5 CLEANING

- A. After installing units, inspect unit cabinet for damage to finish. Remove paint splatters and clean other spots, dirt, and debris. Repair damaged finish to match original finish.

3.6 ADJUSTING

- A. Adjust initial temperature set points.

3.7 DEMONSTRATION

Train Owner's maintenance personnel to adjust, operate, and maintain cabinet unit heaters. Refer to Division 1 Section Closeout Procedures."

END OF SECTION 238339

SECTION 260010 - GENERAL REQUIREMENTS

PART 1 GENERAL

1.1 RELATED DOCUMENTS

- A. Refer to Division 00 and Division 01 and all addenda which are a part of this Section, and all subsequent Sections of Division 26.
- B. Refer to Alternate Proposals for possible changes affecting the extent of this Section of Work.
- C. This Contractor is instructed to review all Specifications of all parts of the Work, including Divisions 21, 22, 23, 25, 27 and 28.
- D. The Work required under Division 26 of the Specifications includes all requirements of all Sections of this Division. In general, the Work consists of furnishing and installing the equipment, service and all other materials necessary to provide the complete electrical system and all work in connection with such systems including labor, transportation, etc., complete in every respect as shown on the plans, herein specified, or reasonably implied as ready for use unless it is otherwise specifically noted or otherwise specified.
- E. The Contractor is also referred to Architectural, Structural, Civil, Mechanical and other drawings pertaining to the project. The above-mentioned Construction Documents, as well as their respective Specifications, are part of the complete Contract Documents.

1.2 DESCRIPTION OF WORK

- A. This work involves the upgrade and renovation of a wastewater treatment facility including new buildings, processes, equipment, control panels, controls, starters, motors and SCADA integration with new or modified electrical services installed, wired and ready for use by the Owner.
- B. Work includes, but is not limited to, the following:
 - 1. Provide the new power service to the buildings complete with all underground work including: modification of the main service equipment, secondary service conductors, underground duct bank, conduit, cable, trenching, concrete, and backfill with restoration of all existing surfaces affected by the work.
 - 2. Provide the new SCADA communication systems services to the control panels complete with all underground work including, underground duct bank, conduit, trenching, concrete, and backfill with restoration of all existing surfaces affected by the work.
 - 3. Coordinate requirements and installation with the respective equipment control panels and equipment provided.
 - 4. Provide the new conduits and boxes for the power and signal communications systems complete with mounting hardware and conduit arrangements.

5. Provide upgrades and extension of existing power for the new buildings and equipment. Provide all feeders, panelboards, junction and pull boxes to complete the electrical system distribution as shown, stated, or reasonably implied. Provide all wiring to all new or replaced equipment as shown or implied on the Construction Documents.
6. Provide all branch circuit panelboards and all branch circuit wiring to all control panels, equipment, and sensors furnished in this work or other trades in order to provide for all power supply needed to complete the process equipment electrical system as shown, stated, or reasonably implied.
7. Provide motor starters where shown, all safety and disconnecting switches, selector switches, operator stations, control panels, pushbuttons, and other control devices complete with all wiring to connect to all motors as furnished under the electrical work or by other trades. All equipment shall be mounted, wired, and ready for use as shown, stated, or implied.
8. Provide all lighting fixtures indoor and outdoor of all types, with all controls, mounted, lamped and wired to provide the complete lighting system as shown, stated, or reasonably implied.
9. Provide all wiring devices and all power outlets completely wired and mounted as shown, stated, or implied.
10. Provide all signal communications conduits and outlet rough-in boxes for low-voltage data acquisition systems, complete with installation of wiring and equipment as shown, stated, or implied.
11. Provide a new or the existing grounding and bonding system from the existing service.

1.3 MATERIALS NOT INCLUDED

- A. Materials not provided by this Contractor, but subject to his installation and or/wiring:
 1. Motors and Control Panels will be furnished by the process equipment vendor as part of the civil package. The electrical contractor is responsible for installation of all equipment provided by other Contractors under other Sections of the Specifications and wired under Division 26.
 2. Exhaust fans, electric cabinet heaters, motor operated dampers, pumps, appliances, air handling and heating equipment will be installed by other trades and wired by this Contractor.

1.4 WORK NOT INCLUDED

- A. Do not provide underground work beyond the points designated on the Construction Documents but do provide for trenching and backfill for underground power and communications cables.
- B. Do not provide process equipment, motors, appliances, tables, work benches, or desks.
- C. Do not provide motor controls or control panels where they are specifically indicated or shown as furnished by others or furnished and/or installed with the equipment.

1.5 GENERAL

- A. It is the purpose of the Construction Documents to indicate the approximate locations of all equipment, panels, controls, etc. The exact location of equipment and outlets may be given from time to time as the work progresses. This Contractor shall ascertain from the Owner's Representative the exact locations and arrange his work accordingly. The Owner's Representative reserves the right to effect reasonable changes in the location of equipment up to the time of roughing-in without additional cost. Exact raceway routings, required pull-boxes and other details are left to the good judgment of the Contractor to produce the most satisfactory installation at least cost.
 - B. This Contractor shall take all field measurements necessary for this work and shall assume responsibility for their accuracy. Do not scale drawings. Any interferences or field problems shall be reported to the Owner's Representative for resolution.
 - C. All items of labor, materials, and equipment not specifically described herein or shown on the plans, but incidental to, or required for, the complete installation and proper operation of the work shall be furnished as if called for in detail by the Specifications or Construction Documents.
 - D. It is the intent of the Contract Electrical Construction Documents and Specifications to describe as accurately as possible the work required. Should any clarification or interferences with other trades be found, they shall be brought to the attention of the Owner's Representative for resolution. Minor discrepancies or interferences as determined by the owner's representative in locations of outlets, necessary wiring, conduits, routings, and fixture locations shall be resolved by the Contractor under field conditions and shall not be justification for additional cost. The Contractor is responsible for the coordination required for conduits to be routed in walls, ceilings or floors as they may occur.
 - E. The design described herein is intended to comply with applicable codes and standards, and with safeguards in excess of code requirements where necessary. It is the responsibility of the Contractor to maintain these standards for achieving a complete and safe installation and to observe and report to the Owner's Representative any items which in his opinion do not conform to the codes and standards or which would improve the safety and/or serviceability of the installation.
 - F. Where any conflict between Construction Documents and Specifications exists, the Specifications shall take precedence.
 - G. Wherever in these Documents the word "provide" is used, it shall be interpreted to mean "furnished and installed" by the Contractor.
 - H. Wherever in these Documents the word "Contractor" or "Subcontractor" is used, it shall be understood to mean the Contractor bidding the work described herein.
- 1.6 EQUIPMENT MANUFACTURER'S DIRECTIONS, DIAGRAMS, AND MANUALS
- A. Except where specifically permitted otherwise, all materials, equipment, and devices furnished by the Contractor shall be new and shall conform to NECA, NEMA, IEEE, ANSI, and Underwriter's Laboratories Standards where applicable and shall bear the CSA and/or UL listing or label mark.

- B. All manufactured articles and all other materials and equipment furnished by the Contractor shall be applied, connected, erected, used, cleaned, and conditioned as directed in the Manufacturer's latest printed instructions.
- C. The Contractor shall compile and deliver to the Owner before request for final payment all installation drawings, wiring diagrams, operating and maintenance manuals, etc. pertaining to all equipment furnished and installed by him.
- D. It shall be the Contractor's responsibility to consult the manufacturer's drawings, installation manuals and instructions for all equipment. All equipment shall be installed in strict accordance with these manuals and instructions.
- E. The Contractor shall arrange for complete testing of all new electrical equipment before energizing. Tests shall be performed by people competent in test procedures and knowledgeable in their performance.
- F. Tests shall be performed in strict accordance with the manufacturer's written specifications and instructions. Any equipment which fails to pass proper testing procedures shall be repaired or replaced by the Contractor as the Owner selects. The cost of any and all repairs or replacements made necessary by faulty equipment supplied or installed by the Contractor shall be at the Contractor's expense and shall not be cause for extra compensation by the Owner.

1.7 INSPECTION

- A. The Owner and his authorized representatives shall have access to and the privilege of inspecting all work and materials as the work progresses. These representatives will have authority to approve or reject any work or materials with the Construction Documents, Specifications, Codes and good engineering practice as a basis for any action taken.
- B. Any work found not in compliance with the Construction Documents, Specifications or applicable standards as listed herein shall be repaired or replaced by the Contractor, as deemed necessary by the Owner or his representatives. Any such additional work by the Contractor as considered necessary by the Owner for the Contractor's work to comply with the Contract Documents as described herein shall not be justification for additional compensation by the Contractor.

1.8 COORDINATION OF WORK

- A. This Contractor is responsible to meet all completion dates set by the Owner, and shall be able to furnish all labor of various classes required to meet schedules and completion dates. This Contractor shall familiarize himself with the various manufacturers on delivery and arrange for delivery of equipment and materials so as not to hinder or delay any completion dates for electrical work or other trades which are affected by the electrical work.

1.9 SAFETY AND CLEANING UP

- A. It shall be the Contractor's responsibility to maintain a clean, safe work place while performing his work and upon leaving the site. Live electrical parts of fixtures, devices and equipment shall be completely protected to prevent accidental injury to others in the building. All stairways, halls and exits shall be left with free access. Tools, toolboxes, ladders, materials, etc., shall be kept in a confined area away from normally occupied areas when not in use.
- B. This Contractor shall use all possible care to avoid soiling the floors and walls. No cutting, threading or bending of conduit will be permitted in finished areas of the building. Oily waste, rags and other flammable materials must be removed from the building immediately after use. Accumulations of rubbish or stored materials of any kind will not be permitted in any public or finished area.
- C. The Contractor must include in his contract price the costs of barricades, signs, fall protection apparatus, fences and other safety devices which will be necessary to safeguard the workplace and excavations.
- D. This Contractor will be held responsible for damage to other work caused by his work or through the negligence of his workmen. All patching or repairing of damaged work shall be done by persons or Contractors normally experienced in the work to be performed; such Contractors or Subcontractors shall be subject to prior approval of the Owner's Representative. The cost of such work shall be paid by the Contractor.

1.10 INTERFERENCES, CUTTING, AND PATCHING

- A. The Contractor shall predetermine the location, size, etc., of all chases and openings necessary in new construction for the installation of his work and shall be responsible to provide all such openings. He shall set all sleeves, inserts and hangers and be responsible for their proper location.
- B. All outlets, switches, and receptacles shall be centered with regard to paneling, trim, equipment, etc., and shall line with either bottom or top of masonry courses. The Contractor shall carefully review the Architectural elevations for exact locations and mounting heights for switches, receptacles, luminaires or appliance requirements and placement. These detailed plans take precedence over electrical floor plans and specifications for actual locations or quantities.
- C. Should any structural difficulties prevent the installation of outlets, setting of cabinets, running of conduits, or other electrical construction at points shown on the Construction Documents, the minor deviations required for a satisfactory installation, as determined by the Owner's Representative, shall be performed at no additional cost.
- D. Do not provide general painting of interior raceways or boxes. However, all enclosures and equipment shall be left in like-new condition, and any finished painted surfaces shall be restored to original quality as furnished by its manufacturer.

1.11 RECEIPT OF PORTABLE OR DETACHABLE PARTS

- A. The Contractor shall retain in his possession and shall be responsible for all portable or detachable portions of the installation such as fuses, keys, locks, etc., until the

completion of the work, and shall turn them over to the Owner and obtain itemized receipt. This receipt, together with a certificate of approval, shall be attached to the Contractor's request for final payment.

PART 2 PRODUCTS

2.1 SHOP DRAWINGS

- A. The Contractor shall submit electronic copies of Manufacturer's certified drawings to the Owner's Representative for approval before purchasing the equipment, in accordance with the Contract Documents. Contractor shall refer to General Conditions for exact submittal requirements. Failure to gain prior approval by the Owner's Representative shall not relieve the Contractor for supplying the equipment as specified herein. Shop Drawings are required on the following items:
 - 1. Switchboards, distribution panels, control panels
 - 2. Branch circuit panelboards
 - 3. Transformers
 - 4. Disconnect switches, motor starters, individually mounted circuit breakers
 - 5. Lighting equipment, lighting controls
 - 6. SCADA communications structured cabling system
- B. The Contractor shall review each set of Shop Drawings before submission to the Owner's Representative. The Contractor shall verify the Shop Drawings accurately and correctly identify the equipment as specified and sufficient information is included for the complete evaluation by the Owner's Representative.
- C. All Shop Drawings shall be stamped by the Contractor indicating the date and status of his review. No Shop Drawing shall be submitted to the Owner's Representative unless it has been reviewed and approved by the Contractor.
- D. The Contractor shall submit Shop Drawings of all equipment as stated even if no deviation of the specification is made and such equipment is exactly as specified herein.
- E. Specific submittal requirements and content may be listed in other sections. In general, provide submittals only as listed in these specifications, and only for pertinent equipment components; not general, unedited "marketing" type material.

2.2 STANDARDS AND SUBSTITUTIONS

- A. It is the intent of these Specifications to describe and require materials and equipment of a particular quality and standard. Wherever in these Documents a manufactured specific item is designated, the Contractor's proposal shall be based on furnishing the specific item as specified. Refer to Division 00 and 01 for additional requirements.
- B. Within ten (10) days after acceptance of his proposal, the Contractor, at his option, may submit items for substitutions for those specified. All such proposed substitutions shall be submitted to the Owner's Representative for prior acceptance before any order or reservation is placed by the Contractor, and shall include all necessary drawings,

descriptive material, catalog numbers and other pertinent information deemed necessary by the Owner's Representative for the evaluation of the item to determine its suitability for acceptance.

- C. The Contractor shall also include a cost breakdown indicating any savings or additional cost to be awarded to or incurred by the Owner should he accept any or all such substitutions.
- D. Failure by the Contractor to gain acceptance of any or all such substitutions by the Owner's Representative shall in no manner be justification for additional cost or relieve the Contractor from providing the specified items herein described.
- E. The Owner's Representative reserves the right to accept or reject proposed substitutions and to limit or extend the time allowed for their submittal.
- F. Wherever in these Specifications more than one manufacturer is listed for a specific item of equipment, the Contractor's proposal shall be based on furnishing equipment manufactured by one of those listed.
- G. Should the Contractor elect or choose other than the first item as specified, he shall be responsible to provide complete and proper fit, installation, operation, and adjustment for the equipment he intends to use. In addition, the Contractor shall provide any and all adjustments of other related or connected equipment which may be affected by the choice of the associated equipment.

PART 3 EXECUTION

3.1 CODES, PERMITS, AND INSPECTIONS

- A. All work shall be executed in accordance with the latest National Electrical Code and the Ohio Building Code, and any Local, City, or County Codes in effect at the time of construction.
- B. At all times during which the Contractor or any Subcontractor are engaged in work covered by these Documents, all requirements of the Occupational Safety and Health Act shall be observed.
- C. The Contractor shall secure and pay for all permits from all agencies and obtain all inspections required for the completion of the electrical work. All permits and certificates of inspection and approval signed by the controlling building department shall be furnished in duplicate to the Owner's Representative and shall become the property of the Owner.

3.2 WORKMANSHIP

- A. All electrical work shall be installed under the direct supervision of a skilled journeyman electrical foreman. All work shall be tested, inspected, and certified approved as to materials and workmanship by proper authority prior to acceptance.

- B. The installation shall be installed and arranged so that its component parts will function as a workable system complete with all accessories necessary for its operation and shall be left with all equipment properly adjusted and in working order. The work shall be executed in conformity with the best accepted standard practice to contribute to efficiency of operation and maintenance, maximum accessibility, and appearance and minimum cost in construction of future alterations and additions. It shall also be executed that the installation will conform with and adjust itself to the building structure, its equipment and its usage.
- C. Electrical work shall be installed by journeyman electricians under the direct supervision of a competent foreman at all times. At no time shall electrical work be installed by apprentice electricians without the immediate on-the-job supervision of a journeyman electrician.
- D. The workmanship of all installed electrical equipment shall be subject to final approval of the Owner's Representative. Any work which does not meet recognized standards of proper installation shall be repaired or replaced by the Contractor at the Owner's Representative discretion. The cost of any repairs and/or replacements necessary due to faulty workmanship shall not be justification for additional compensation by the Contractor.

3.3 VISITING THE SITE

- A. The Contractor shall visit the site before submitting his proposal, compare the Construction Documents with the existing work and inform himself of all pertinent local conditions including location accessibility and general character of the site, the character and extent of existing work within or adjacent to the site, and any other work being performed thereon at the time of the submission of his bid. Failure to visit the site will in no way relieve the Contractor from the necessity of furnishing any materials or performing any work that may be required to complete the work in accordance with these Documents. Lack of knowledge will not be acceptable as a valid excuse for granting any extra compensation or for failure or neglect to perform any or all work in this Contract.

3.4 GUARANTEE OF CONTRACT WORK

- A. The Contractor shall guarantee the materials used in the installation herein specified are the best of their respective kinds and that they shall be put together in a thorough and workmanlike manner under the immediate supervision of the Contractor. He shall guarantee that he will correct any defects in workmanship, materials, or effectiveness of any portion of the equipment and/or systems within one (1) year after completion and acceptance of the installation. This is to be done without cost to the Owner, provided that such defects are due to faulty material and/or workmanship which were provided by the Contractor.
- B. Certain items of equipment may carry a requirement for longer guarantee periods, as specified elsewhere in the Contract Documents.

3.5 INTERFERENCES

- A. It is the intent of the Electrical Construction Documents and Specifications to describe as accurately as possible the work required. Should any inconsistencies, or interferences with other trades be found, they shall be brought to the attention of the Owner's Representative for resolution. Minor discrepancies and interferences in locations of equipment, outlets, conduit routing and fixture locations, shall be resolved by the Contractor under field conditions and shall not be justification for additional cost.

3.6 CHANGES IN WORK

- A. The Owner, without invalidating the Contract, may order extra work or make changes by altering, adding to or deducting from the work, with the contract "Lump Sum Price" being adjusted accordingly as described in Division 00 or 01.

3.7 STORAGE OF MATERIALS

- A. Materials furnished and delivered by this Contractor for the work may be placed or stored on the property of the Owner only in a location as will be designated by the Owner or his representative. However, the Contractor shall assume full responsibility for all materials so stored.

3.8 PAINTING

- A. The Contractor shall provide painting of boxes, hangers, and supports used in all outdoor installations with rust inhibiting paints unless galvanized. In addition, all manufacturers' enclosures and equipment shall be left in like-new condition, and any furnished surfaces shall be restored to original quality.
- B. In general, exposed boxes, conduit and fittings in indoor locations will not require painting but shall have all surfaces as furnished by the manufacturer left in clean, like-new condition.
- C. All equipment, boxes, etc., installed outdoors exposed to weather shall be corrosion resistant with a protection of galvanizing or not less than two (2) coats of rust inhibiting paints.

3.9 RECORD DRAWINGS

- A. Whenever field changes, modifications or revisions to the Contract Construction Documents are permitted or required, it shall be the Contractor's responsibility to record such changes on a set of the contract construction prints. These prints shall not be utilized for any other purpose. Field changes shall be recorded to indicate as neatly and accurately as possible all changes in locations, routing and other incidental information as necessary to convey to the Owner the exact as-installed status of the electrical system.
- B. The Contractor shall record final locations of all underground lines within or outside the building by depth from finished floor or grade and by offset measurement from

building components or surface improvements such as building columns, building walls, curbs, edges of walks, etc.

3.10 SMOKE AND FIRE BARRIERS

- A. The Contractor shall be responsible to locate and provide all openings in floors, ceilings and walls to allow for his conduit penetrations. All conduit penetrations shall be sleeved using steel casings embedded in concrete floors or by core drilling. The Contractor shall submit to the Owner's Representative all locations and sizes of openings which must be provided for this work before drilling or setting any sleeves. Final locations and sizes of all openings shall be subject to the Owner's Representative final approval.
- B. The Contractor shall provide all fire stops and smoke and fire barriers around all conduit penetrations provided under this work. All fire barriers shall be UL listed and recognized suitable by factory mutual and NFPA. Fire barriers shall restore all surfaces to be at least one hour, or the minimum fire rating of the floor, wall or ceiling penetrated. Barriers shall completely fill the openings and shall be securely anchored to prevent accidental removal. All smoke and fire barriers shall be made using only recognized materials and will be acceptable subject to the Owner's Representative final approval. Smoke and fire barriers may be Fire Seal, STI, DuPont or U.S. Gypsum.
- C. Materials may include the following, as applicable to the work:
 - 1. Firestop mortar
 - 2. Intumescent firestop sealants and caulks
 - 3. Elastomeric firestop sealants and caulks
 - 4. Endothermic firestop sealants and caulks
 - 5. Firestop putty
 - 6. Firestop pillows
 - 7. Firestop collars
 - 8. Wrap strips
 - 9. Cast-in-place devices
 - 10. Firestop foams
 - 11. Light fixture covers
 - 12. Composite sheets
- D. Firestopping materials shall conform to Flame (F) and Temperature (T) ratings required by local building code and as tested by nationally accepted test agencies per ASTM E-184 or UL 1479 fire tests in a configuration that is representative of field conditions.
- E. Manufacturer's engineering judgments shall be accepted for non-standard applications or where no tested system exists. Drawings for engineering judgments must indicate the UL tested system or systems upon which the judgment is based, in order to evaluate the engineering judgment against a known performance.
- F. Firestopping material shall be non-halogenated, lead and asbestos free and shall not incorporate nor require the use of hazardous solvents.
- G. Firestop products which dissolve in water after curing are not acceptable.

- H. Firestopping materials shall not shrink upon drying as evidenced by cracking or pulling back from contact surfaces.
- I. All firestopping materials for the electrical work shall be manufactured by one manufacturer (to the maximum extent possible).
- J. Firestopping shall be performed by a Contractor trained and approved by the Firestop Manufacturer.

3.11 FUTURE ADDITIONS

- A. Note that certain provisions have been made in this installation to allow for the installation of future equipment and extension of wiring. The Contractor shall arrange his work under this contract to allow for installation of the future work. In no way shall any work performed under this contract interfere with or prevent installation of such future additions when and if required.

3.12 IDENTIFICATION

- A. The Contractor shall provide fully engraved micarta nameplates to match existing equipment nameplates for all equipment provided by him including panelboards, motor controllers, control panels, safety switches, transformers and one for each circuit designated from main distribution panels. Each plate shall identify the equipment, voltage class, phase, ampere rating and purpose of the specific circuit or equipment involved. Nameplates shall be fixed to equipment enclosures with rivet pins or epoxy adhesive.
- B. Provide a permanent nameplate or plaque to identify the maximum fault current amperes available at the main service disconnecting means, in accordance with National Electrical Code Article 110.
- C. Permanently mounted signs, plaques and/or directories shall be provided to meet the requirements of the National Electrical Code Articles 700, 701, 702, and 705.

END OF SECTION 260010

SECTION 260020 - ELECTRICAL DEMOLITION

PART 1 - GENERAL

1.1 RELATED DOCUMENT

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

1.2 DESCRIPTION OF WORK

- B. Contractor shall visit and examine the site prior to bidding to ascertain the existing conditions and limits of demolition and construction. Adjoining areas shall be maintained in operation.
- C. Remove all items of existing construction not to remain as a part of the final project. Unless otherwise noted:
 - 1. Remove all existing electrical equipment, wiring, and conduit in the areas to be renovated, in this project.
 - 2. Existing equipment serving other areas, but interfering with the construction, shall be relocated as necessary.
 - 3. Certain items of electrical equipment are noted to be relocated and reinstalled as part of this project.
- D. Any demolition indicated on the Construction Documents is shown in general to indicate the extent of demolition and is not to be considered as a record drawing of existing conditions. Accordingly, the Contractor shall be responsible for complete demolition of the electrical work indicated including any buried items or any existing items not shown on the Construction Documents. Before demolition and before submission of proposed methods and operations, the Contractor shall be responsible to obtain, for reference, any existing record Construction Documents and to conduct any appropriate field testing to determine the nature of the existing electrical work to be demolished.
- E. Protect existing work remaining in place and protect the public.
- F. Repair and restore to original sound condition all items or portions of electrical work which are not noted to be demolished but are damaged by work under this contract.
- G. It shall be the Contractor's responsibility to protect and retain power to all existing active equipment which shall remain.
- H. Contractor shall reconnect any equipment being disturbed by this renovation yet required for continued service to same or nearest available panel.
- I. Where work by the General Contractor (wall removal, new or relocated wall opening, etc.), results in the removal, relocation, or refeeding of electrical devices or lighting

fixtures, the Contractor shall disconnect or reconnect as required all active devices remaining on that circuit or system.

- J. Contractor shall “ring out” all circuits in existing panel affected by this alteration. Where additional circuits are needed, reuse circuits available for reuse, or provide new circuits. Tag all unused circuits as spare, replace all inoperative or defective circuit breakers. Tighten all connections.

PART 2 - PRODUCTS AND PROCEDURES

2.1 COORDINATION

- A. Coordinate and sequence demolition so as not to cause shut-down of operation of surrounding areas.
- B. Do not proceed with demolition without written authority to proceed.
- C. Proceed with demolition in a systematic manner and coordinate all trades involved.
- D. Carefully remove equipment, materials, or fixtures which are to be reused.
- E. Disconnect or shut off service to areas where electrical work is to be removed. Remove all electrical fixtures, equipment, and related switches, outlets, conduit and wiring which are not a part of the final project in all areas where work of this contract is to be performed.
- F. Refer to the mechanical Construction Documents for mechanical equipment which must be disconnected by this Contractor for removal or abandonment by the Mechanical Contractor.
- G. Remove all conduit wire, boxes, and fastening devices, as required to avoid any interference with new installation. Abandoned underground conduit to be capped at both ends.

2.2 SHUT-DOWN PERIODS

- A. Arrange timing of shut-down periods of all in-service panels with Owner or his representative. Do not shut down any utility without prior written approval.
- B. Keep shut-down period to a minimum or use intermittent period as directed by the Owner’s Representative.

PART 3 - EXECUTION

3.1 EXISTING PANELBOARDS

- A. Where existing circuits are indicated to be reused, Contractor to use sensing measuring devices to verify that circuits feed project area or are not in use.

- B. Remove existing conduit and/or wiring no longer in use from panel back to equipment.
- C. Provide new typewritten updated directories where existing circuits have been modified or re-assigned.

3.2 SALVAGEABLE ITEMS

- A. Items of salvageable value to the Owner shall be removed and protected by the Contractor and turned over to the Owner as directed.
- B. All removed equipment shall be disposed of by this Contractor unless directed to do otherwise by the Owner's Representative. Disposal responsibilities include:
 - 1. Mercury Abatement
 - a. Remove and recycle mercury containing fluorescent and HID lamps as universal waste, in accordance with the EPA universal waste rule.
 - b. All Mercury-related operations shall be performed in accordance with the EPA universal waste rule. Regulation 40 CFR Parts 260, 261, 264, 265, 268, 270 and 273 for mercury containing fluorescent and HID lamps.
 - 2. PCB Abatement
 - a. Remove and incinerate ballasts which contain polychlorinated biphenyl (PCB), in accordance with current environmental regulations.
 - b. All PCB-related operations shall be performed in accordance with EPA Regulation 40 CFR 761, Polychlorinated Biphenyls, Manufacturing, Process, Distribution in Commercial Use Prohibition.
 - 3. Properly dispose of all ionization type smoke detectors during demolition work as required by local, state, and regional codes.
 - 4. Properly dispose of all batteries during demolition work as required by local, state, and regional codes; this also includes any other electrical equipment containing lead.
- C. Items of salvageable value to the Contractor may be removed as the work progresses. Salvaged items must be transported from the site as they are removed. Storage or sale of removed items on the site will not be permitted.

3.3 REUSABLE ELECTRICAL EQUIPMENT

- A. Disconnect, remove, or relocate all existing electrical material and equipment that interferes with new installation. This includes, but is not limited to; panels, lighting fixtures, wiring devices, signal equipment, exhaust fans, baseboard heaters, unit heaters, etc.
- B. Relocate existing lighting fixtures as indicated on plans. Fixtures shall be cleaned and re-lamped, also tested to confirm if fixture is in good working condition before installation at new location.

END OF SECTION 260020

SECTION 260519 - CONDUCTORS

PART 1 - GENERAL

1.1 RELATED DOCUMENT

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

1.2 DESCRIPTION

- A. Provide all labor, material, equipment, tools, and services necessary for, and incidental to, the proper installation of the complete electrical wire and cable systems herein specified, and as shown on the Construction Documents.

1.3 QUALITY ASSURANCE

- A. All conductors shall be copper and shall conform to the requirements of the National Electrical Code (NEC), IACS, ASTM, and IPCEA, and shall be Underwriters Laboratories Listed.

1.4 PRODUCT DELIVERY, STORAGE, AND HANDLING

- A. Materials shall be stored to protect them from damage prior to installation. Material should not be stored directly on the ground or floor and shall be kept as clean and dry as possible and free from damage or deteriorating elements.
- B. In general, do not deliver items of electrical equipment to the project substantially before the time of installation. Limit each shipment of bulk and multiple-use materials to the quantities needed for installations within three (3) weeks of receipt.
- C. Deliver products to project properly identified with names, types, grades, compliance labels and similar information needed for distinct identification. Materials must be adequately packaged or protected to prevent deterioration during shipment, storage and handling.

PART 2 - PRODUCTS

2.1 FABRICATION AND MANUFACTURE

- A. All feeder, branch circuit and control conductors shall be 600-volt, 90-degree centigrade, single conductor copper cables, Type 'THWN', 'THHN' or XHHW.
- B. Wiring on the secondary of VFD drives shall be 600-volt VFD rated cable with flexible stranded tinned copper conductors, cross-linked polyethylene (XLPE) insulation and 85% coverage tinned copper braided shield with an overall PVC jacket.

- C. Cords for equipment connections to equipment shall be abrasion-resistant, industrial grade, heavy duty rated 600-volts, heat resistant, rubber insulated, portable cable with neoprene jacket Type 'SOOW' of extra flexible stranded copper.
- D. SCADA ethernet communications systems shall be Cat 6, 4-pair, twisted/shielded pair outdoor rated. Provide proper terminations and connections to devices.
- E. 4-20 mA signal wire shall be 2/c – 20 AWG, 10-stranded tinned copper with foil shield and PVC insulation material.
- F. Multi-conductor signal wire shall be 18 AWG minimum, tinned copper, PVC jacket.
- G. All other special power cable and signal wires shall be multi-conductor, 18 AWG minimum as noted on Construction Documents, or as required by the vendor and/or hereinafter specified.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. For extension of existing distribution systems, match the color-coding used in the existing systems, as required by the National Electric Code.
- B. For new distribution systems, color code branch circuit and feeder conductors as follows:
 1. 208Y/120 volt, 3 phase, 4 wire system
 - a. Phase A – black
 - b. Phase B – red
 - c. Phase C – blue
 - d. Neutral – white
 - e. Grounding - green
 2. 480Y/277 volt, 3 phase, 4 wire system
 - a. Phase A – brown
 - b. Phase B - orange
 - c. Phase C – yellow
 - d. Neutral - white with tracer
 - e. Ground - green
 3. In addition to these requirements, also provide color coding of conductors at junction or pullboxes.
- C. All rough-in work in the building shall be completed before wires are installed into conduits. The conduits shall be cleaned out by pulling a swab through the tubing with a fish tape, and wires shall be pulled through conduit in such a manner as to avoid kinking or injuring the insulation. Thermoplastic wire shall not be pulled where ambient temperatures are lower than 15 degrees F.
- D. Deliver products to project properly identified with names, types, grades, compliance labels and similar information needed for distinct identification. Materials must be

adequately packaged or protected to prevent deterioration during shipment, storage and handling.

- E. All joints and splices in wire #10 AWG and smaller shall be twisted and made mechanically strong with electrical spring pressure type connectors similar to "Scotch-lok" of proper size, rated 600 Volts and shall be wrapped with half lapped layers of plastic tape.
- F. Solderless type connectors of approved and accepted types shall be used on splices and taps in wires #8 AWG and larger. All splices shall be insulated with a minimum of two (2) half-lapped layers of "Scotch" #88 and #22 plastic tape. All connectors having irregular surfaces shall be properly padded with "Scotch-fill" to eliminate sharp corners and voids before applying plastic tape.
- G. Branch circuit wires in panels and control panels shall be neatly arranged with all surplus wire cut off and all wires tied with nonmetallic ties. Metallic ties will not be permitted. Only one conductor shall be attached to a terminal screw or lug unless terminal is UL Listed for more than one (1) terminal.
- H. All mechanical wire and cable termination shall be torque tightened with torque wrench or torque screwdriver to manufacturers recommended torque values.
- I. For feeders and equipment circuits 40 ampere rated and above, the intent of the design is to install a maximum of three (3) current-carrying conductors in a single conduit (raceway), utilizing the full conductor ampacities allowed and defined in the National Electrical Code Article 310. Combining of four (4) or more current-carrying conductors in a single raceway must be reviewed and approved by the Owner's Representative.

END OF SECTION 260519

SECTION 260520 - METAL CLAD CABLE

PART 1 – GENERAL

1.1 RELATED DOCUMENT

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

1.2 DESCRIPTION

- A. Provide all labor, material, equipment, tools, and services necessary for, and incidental to, the proper installation of a type MC cable branch circuit system.

1.3 QUALITY ASSURANCE

- A. All cable and fittings shall conform to the requirements of the National Electrical Code (NEC), NEMA, JIC, ANSI, and shall be labeled with the Underwriter's Laboratories Seal of Inspection.
- B. Metal Clad Cable shall be constructed in strict accordance with Underwriter's Laboratories, Inc., standard for Metal Clad Cables, UL 1569. The cable shall bear the UL label and the manufacturer's 'E' number. In addition, Metal Clad Cable must meet the requirements of the latest edition of the NEC, NFPA 70, Article 330, Metal Clad Cable.

1.4 PRODUCT DELIVERY, STORAGE, AND HANDLING

- A. Materials shall be stored to protect them from damage prior to installation. Material should not be stored directly on the ground or floor and shall be kept as clean and dry as possible, and free from damage or deteriorating elements.
- B. In general, do not deliver items of electrical equipment to the project substantially before the time of installation. Limit each shipment of bulk and multiple-use materials to the quantities needed for installation within three (3) weeks of receipt.
- C. Deliver products to project properly identified with names, types, grades, compliance labels, and similar information needed for distinct identification. Materials must be adequately packaged or protected to prevent deterioration during shipment, storage, and handling.

1.5 PERMITTED USE

- A. Type MC cable may be used in lieu of conduit and wire for 20 and 30 ampere branch circuits.
- B. Type MC shall be installed within stud walls, furred walls, above accessible ceilings or concealed in casework. MC cable is not permitted in an exposed location where

subject to physical damage or where accessible by unqualified individuals.

- C. Type MC Luminary® Cable or equivalent may be used for lighting control and dimming circuits in Class 1 with Class 2 & 3 per MC PCS listing.

1.6 SUBMITTALS

- A. Shop Drawings, if listed in Section 260010 shall be submitted for all equipment provided under this Section.
 - 1. Product Data: Provide literature for the MC cable and connectors, including construction details and UL listing.
 - 2. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use, if any.

PART 2 - PRODUCTS

2.1 QUALIFICATIONS

- A. Manufacturer: AFC, Southwire, General Cable, or equivalent.

2.2 METAL CLAD CABLE

- A. Description: Metal Clad Cable.
- B. Conductor: Copper, Solid, or Stranded.
- C. Insulation Voltage Rating: 600 volts.
- D. Insulation Temperature Rating: 90 degrees C.
- E. Insulation Material: Dry Locations: Thermoplastic (THHN), or equivalent, Wet Locations: Thermoplastic (THWN), or equivalent.
- F. Armor Material: Aluminum, Class A.
- G. Armor Design: Interlocked type.
- H. Grounding: Full size copper grounding conductor.
- I. Use only UL (MCI-A listed fittings) for connectors listed for the purpose.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install MC cable in accordance with manufacturer's instructions and in accordance with Article 300 and Article 330 of NFPA 70. Follow manufacturer's instructions and use proper tools when installing the cable and connecting the cable fittings and boxes.

- B. Installation shall be neat and workmanlike.
- C. Support and route cable at right angles to the building or wall structure.
- D. Where PVC Jacketed MC Cables are used (corrosive environments) and the cable is surface mounted; supports shall be two times the NEC or every 3 feet minimum to avoid the cable sagging.
- E. Verify continuity of each branch circuit and grounding conductor.

END OF SECTION 260520

SECTION 260526 - GROUNDING

PART 1 - GENERAL

1.1 RELATED DOCUMENT

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

1.2 DESCRIPTION

- A. Provide all labor, material, equipment, tools, and services necessary for, and incidental to, the proper installation of the complete electrical grounding systems herein specified, and as shown on the Construction Documents.

1.3 QUALITY ASSURANCE

- A. All grounding materials and equipment shall be copper and/or copper clad and shall conform to the requirements of the National Electrical Code (NEC), IEEE, NEMA, JIC, ANSI, and shall be labeled with the Underwriters' Laboratories Seal of Inspection.

1.4 PRODUCT DELIVERY, STORAGE, AND HANDLING

- A. Materials shall be stored to protect them from damage prior to installation. Material should not be stored directly on the ground or floor and shall be kept as clean and dry as possible and free from damage or deteriorating elements.
- B. In general, do not deliver items of electrical equipment to the project substantially before the time of installation. Limit each shipment of bulk and multiple-use materials to the quantities needed for installations within three (3) weeks of receipt.
- C. Deliver products to project properly identified with names, types, grades, compliance labels and similar information needed for distinct identification. Materials must be adequately packaged or protected to prevent deterioration during shipment, storage and handling.

1.5 PERFORMANCE, SEQUENCING, AND SCHEDULING

- A. The Contractor is responsible to test the entire grounding system, including all conductors and connections before the power distribution system is energized. Improper grounding conditions shall be corrected before occupancy of the building.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Provide a copper equipment grounding busbar in all branch circuit panelboards and distribution panels.

- B. Provide ground “rings” and/or ground “rods” and equipment grounding as indicated on the Drawings.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. The entire light and power system shall be permanently and effectively grounded in accordance with the latest issue of the National Electrical Code, including service equipment, panelboards, switch and starter enclosures, motor frames, grounding type receptacles, and other exposed non-current carrying metal parts of the electrical equipment.
- B. All cord connected appliance frames shall be grounded to the conduit system through a grounding conductor in the cord. Flexible connections to motors shall be jumped with a braid equipment grounding conductor.
- C. Flexible metallic conduit equipment connections utilized in conjunction with single phase branch circuits shall be provided with suitable green insulated grounding conductors connected to approved grounding terminals at each end of the flexible conduit.
- D. Neutral conductors shall be grounded at the source, but they shall not be used for equipment grounding.
- E. Identify equipment grounding conductors by a green color code, and neutral conductors with a white color code.
- F. Grounding of the electrical system shall be by means of insulated grounding conductor installed with all feeders and branch circuit conductors in all conduits. Grounding conductors shall be sized in accordance with NEC 250 and shall run from grounding bus of serving panel to ground bus of served panel, grounding screw of receptacles, lighting fixture housing, light switch outlet boxes or metal enclosures of service equipment.
- G. Grounding conductors shall be stranded.

END OF SECTION 260526

SECTION 260533 - RACEWAYS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification Sections, apply to work of this section.

1.2 DESCRIPTION

- A. Provide all labor, material, equipment, tools, and services necessary for, and incidental to, the proper installation of a complete electrical raceway system herein specified, and as shown on the Construction Documents.

1.3 QUALITY ASSURANCE

- A. All raceways and fittings shall conform to the requirements of the National Electrical Code (NEC), NEMA, JIC, ANSI, and shall be labeled with the Underwriters Laboratories Seal of Inspection.

1.4 PRODUCT DELIVERY, STORAGE, AND HANDLING

- A. Materials shall be stored to protect them from damage prior to installation. Material should not be stored directly on the ground or floor and shall be kept as clean and dry as possible and free from damage or deteriorating elements.
- B. In general, do not deliver items of electrical equipment to the project substantially before the time of installation. Limit each shipment of bulk and multiple-use materials to the quantities needed for installation within 3-weeks of receipt.
- C. Deliver products to project properly identified with names, types, grades, compliance labels and similar information needed for distinct identification. Materials must be adequately packaged or protected to prevent deterioration during shipment, storage and handling.

PART 2 - PRODUCTS

2.1 CONDUITS AND FITTINGS

- A. Intermediate Metal Conduit, (IMC) and Rigid Steel Conduit shall be hot dipped galvanized or sherardized heavy wall rigid steel.
- B. Electric Metallic Tubing (EMT) shall be zinc coated steel electrical metallic tubing.
- C. Flexible Metal Conduit shall be manufactured of heavily zinc coated sheet metal strips interlocked to form a flexible, smooth wiring channel.

- D. Liquid-tight Flexible Metal Conduit shall be single strip, continuous, flexible, interlocked, double-wrapped steel, galvanized inside and outside; forming smooth internal wiring channel; with liquid-tight jacket of flexible polyvinyl chloride (PVC).
- E. Conduit fittings for exposed work shall be corrosion resistant. Fittings shall provide ample wiring space and shall have smooth round edges and full-threaded hubs.
- F. EMT fittings, connectors and couplings shall be threadless gland setscrew tightened type with insulated throat.
- G. PVC conduit and fittings shall be Schedule 40, suitable for direct burial. All fittings and solvent welding materials shall be of the same manufacturer.
- H. Rigid aluminum conduit and fittings may be used above ground for exterior work only. Such conduits shall be manufactured in accordance with ANSI C80.5, U.L. 6A and federal specification WW-C-581.

2.2 BOXES

- A. Exposed outlets shall be of the cast malleable iron or special alloy conduit fitting type.
- B. Unless otherwise noted, all concealed outlets shall be galvanized or sheradized pressed steel outlet boxes to accommodate device indicated by symbol, considering also code requirements, number and size of conductors and splices, and consistent with type of construction.
- C. All junction, pull and outlet boxes shall be UL listed and suitable for the installation. In general, outlet boxes for wall receptacles, wall switches and communications outlets shall be single gang 2-1/8" deep minimum.
- D. Outlet boxes installed at lighting fixtures shall be 4" octagon, 2-1/8" deep minimum.
- E. The Construction Documents may indicate junction box location and sizes for selected equipment. Additional locations and quantities of boxes is left to the judgment of the Contractor to produce the most satisfactory installation at least cost.
- F. Pull boxes and junction boxes for lighting, power, and control systems larger than 6" x 6" x 4" shall be constructed of galvanized hot-rolled sheet steel. Sizes of the boxes shall be as noted or determined by the Contractor in the field, based on a minimum full circle loop bends of conductors as recommended by the wire manufacturer, plus the convenience of making clean wire splices and connections.
- G. All pull boxes and junction boxes shall be accessible and shall be fitted with a full side and/or bottom removable cover plate, securely and tightly held in place with machine screws in properly drilled and tapped holes and shall be equipped with dust-tight gaskets.
- H. Conduit supports for horizontal or vertical single conduit runs shall be hot dipped galvanized heavy duty steel straps, minerallac clamps or channel system with appropriate components. Spring type pressure clamps may be used with conduits

through 3/4".

2.3 UNDERGROUND DUCT BANKS

- A. All underground duct shall be nonmetallic, size as shown on drawings and suitable for complete concrete encasement as detailed on the drawings. All duct shall meet or exceed the requirements of NEMA TC-6, UL-651 and ASTM-F 512 for encasement. Duct shall be UL listed for use with power and communication circuits. All underground duct shall be Carlon Company, Schedule 40 PVC, power and communications duct.
- B. All fittings used with the underground duct bank shall be suitable for the specific use and shall be as manufactured by the same manufacturer as the duct unless noted otherwise. Field bends where required shall be made only with the proper nonmetallic conduit bending equipment employing infrared energy to heat the material. Galvanized steel, IMC long sweep 90-degree bends shall be used wherever terminating above grade or where exposed to damage.
- C. Expansion joints and fittings shall be installed where shown and elsewhere where necessary to prevent thermal stress on the raceways and duct bank.
- D. Provide proper conversion fittings where conversion from plastic to metal raceway occurs.
- E. All adhesive and bonding agents shall be proper for the material involved and shall be as manufactured and recommended by the same manufacturer as the duct.

2.4 MANHOLES

- A. All new manholes shall be constructed and installed as shown and described on the Construction Documents. In general, it is intended that manholes be precast or prefabricated construction, including the appliance, hardware, ground rods, ground grids, pulling irons, ladder, and all other associated equipment including the engraved manhole covers as shown on the Construction Documents for all manhole installations.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Exposed conduit will be permitted in process areas and in exposed structure areas for motor feeders, controls, and equipment.
- B. Exposed conduits shall be run at right angles and parallel to the building structural members and shall avoid proximity of hot water pipes. Conduits shall be run as high as possible, "tight" to building structural members so as to permit installation of other utilities and systems. All vertical runs shall be plumb.
- C. Conduit installation in exterior walls shall be kept at a minimum and shall be so placed only where absolutely necessary. Horizontal conduit runs in masonry walls are not

acceptable. Under no conditions shall conduit be installed exposed on top of floors.

- D. For long conduit runs and at building expansion joints, conduit runs shall have expansion fittings, complete with bonding jumpers, to relieve the strain of expansion and contraction. Conduits installed through exterior walls, above or below grade, shall be made completely water tight.
- E. Thin wall conduit (EMT) shall not be used where subject to physical damage, laid in concrete slabs, in exterior masonry walls, in damp locations, outside the building, underground, exposed, or in hazardous areas. EMT conduit is only approved for installation in other applications as outlined in the National Electrical Code.
- F. All conduits shall be of the proper standard electrical trade size in accordance with the National Electrical Code and shall be so installed that the required number of conductors may be pulled in without exceeding the manufacturer's recommended pulling tensions. Conduits shall be not less than 3/4" electrical trade size for any purpose whatsoever, nor less than size as specified or noted on the Construction Documents.
- G. Conduits installed in floor slabs shall have minimum 1-1/2" concrete cover. Branch circuit conduits installed in or under concrete slab may be schedule 40 PVC with ground wire.
- H. Rigid steel conduit shall not be run in cinder fill and shall not be run in earth unless protected by at least two inches of concrete on all sides of the conduit, unless otherwise specifically noted on Construction Documents. This Contractor shall prepare all trenches required for underground lines, including excavation and backfill to establish grade or to a level to receive finished paving.
- I. Coupling and threaded hubs for rigid steel conduit shall have no less than five threads of conduit engaged and shall be screwed tight, fully engaged. Long threads known as "running threads" shall not be used, and only manufactured close or short nipples will be permitted.
- J. A properly sized bender shall be used for conduit bends. Conduits larger than 1" shall have bends made with a power bender. Conduit runs between outlets shall not contain more than the equivalent of four 90-degree bends. If more than four 90-degree bends are required on any conduit run, a pullbox, junction box or conduit fitting shall be installed.
- K. All conduit ends shall be reamed after cutting is made and all conduits shall have two (2) locknuts, and bushing at outlet boxes, cabinets, junction boxes, etc., except those terminating at threaded hubs. All bushings larger than one inch shall be insulated bushings, shallow type.
- L. All conduits terminating in junction boxes, outlets, or equipment, and all conduit stubs shall be fitted with threaded blanked bushings, to prevent the entry of foreign materials, rain, or excessive moisture during the building rough-in prior to installation of wiring. Paper, rags, or corks shall not be used for plugs.

- M. Conduit runs in general shall be supported on trapeze hangers and for horizontal runs shall be supported with 1-hole malleable clamps and screws for conduits fastened below horizontal supporting steel or fastened on vertical supporting steel. Bailing wire or perforated strap material shall not be used for supporting or securing conduits. Do not attach work to metal roof decks or Tectum ceiling, if any occur in the building construction. Supports must be able to carry at least twice the actual load. Joint use of hangers with heating and plumbing lines will not be permitted and conduit shall be installed above piping wherever possible.
- N. The Contractor shall provide all pipe hangers, brackets, straps, clamps and supports required to adequately support conduits. Exposed conduits 1-1/2" and under shall be supported on five-foot centers or less, and conduits larger than 1-1/2" shall be supported on eight-foot centers or less. Suitable metal spacers shall be provided to maintain a minimum of 1/2" clearance from walls and ceilings for all conduits run exposed. The spacers and all other supporting hardware shall be cadmium plated clamps, bracket bolts or lead expansive screws anchors, or other similarly approved method. Wood plugs will not be permitted.
- O. Contractor shall furnish and install all pull boxes, junction boxes, splice boxes and fittings wherever necessary or shown on Construction Documents. All boxes shall be made of code gauge steel with screw covers. Provide a pullbox if any conduit transitions for a conduit run totals more than 270 degrees (three 90-degree bends), but in no case shall the Contractor exceed the cable pulling limits as established by the cable manufacturer. The location of all pull boxes shall be fully accessible and will be subject to the approval of the Owner's Representative.
- P. If PVC conduit is used below the ground floor slab, exposed conduits rising from floor to surface panels and/or boxes shall be rigid steel or IMC to the equipment or box enclosure.
- Q. Conduit sleeves are to be completely packed with appropriate fire proofing material and concrete, and all firewalls penetrated by conduit shall maintain the Fire Rating of the penetrated areas. Provide conduit insulating bushings with ground lugs on all conduits terminating in or under distribution panels, unit substations, etc., and ground to the components system ground. Insulating bushings shall be provided at all other locations as required by the National Electrical Code.
- R. At all locations wherever conduit enters structures below ground (such as basements), entries shall be through sleeves and both sleeves and conduit shall be watertight. Sleeves shall be sealed with adjustable interlocking rubber links as manufactured by "Link-Seal" or equal. Conduit penetrations that are not required to be watertight shall be sleeved and filled with silicon foam.
- S. Conduits or other raceway systems that penetrate through fire rated walls, ceilings, decks, smoke partitions, etc., shall be installed so as to maintain the integrity of the fire or smoke rated area.
- T. Unless otherwise indicated for lighting equipment, liquid tight flexible metal conduits shall be used for all connections to all equipment where such equipment is subject to vibration, or to facilitate movement of the equipment for cleaning, maintenance or

repairs. Liquid tight conduits shall be used in lengths of not less than 3-feet nor more than 6-feet. All liquid tight conduits shall include a properly sized equipment grounding conductor regardless of liquid-tight size or length involved or circuit protection.

- U. Conductors installed in vertical raceways shall be adequately supported with approved conductor supports at the intervals stipulated by the National Electrical Code. Conductors shall be supported at points of termination independent of panel lugs.

3.2 UNDERGROUND DUCT BANKS

- A. The underground duct raceway systems shall have concrete encasement or tamped sand encasement, as detailed on the drawings. Concrete used shall be 3/8-inch aggregate with a nominal compressive strength of 4,000 lbs. per square inch. The slump shall be at the upper end of the range, preferably 7 to 8 inches. It should have just enough slump to flow to the bottom of the formation and yet not be so wet as to cause the ducts to float. When placing concrete around the ducts the delivery chute should allow it to fall a minimal distance. Encasement shall start at one end and work toward the other. Do not encase from both ends to the center or from the center out.
- B. Backfill shall be clean, screened fine, topsoil with final cover of hard surface asphalt, concrete walk or turf to restore the original.
- C. The duct bank shall be supported using preformed, interlocking spacers. Spacers shall be as detailed on the drawings.

END OF SECTION 260533

SECTION 262416 - PANELBOARDS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification Sections, apply to work of this section.

1.2 SUMMARY

- A. This Section includes distribution panelboards and lighting and appliance branch-circuit panelboards.

1.3 SUBMITTALS

- A. Product Data: For each type of panelboard, overcurrent protective device, accessory, and component indicated. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.
- B. Shop Drawings: For each panelboard and related equipment.
 - 1. Dimensioned plans, elevations, sections, and details. Show tabulations of installed devices, equipment features, and ratings. Include the following:
 - a. Enclosure types and details for types other than NEMA 250, Type 1.
 - b. Bus configuration, current, and voltage ratings.
 - c. Short-circuit current rating of panelboards and overcurrent protective devices.
 - d. UL listing for series rating of installed devices.
 - e. Features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
 - 2. Wiring Diagrams: Power, signal, and control wiring.
 - 3. Field quality-control test reports.
 - 4. Operation and maintenance data.

1.4 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. Comply with NEMA PB 1.
- C. Comply with NFPA 70.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Basis-of-Design Product: Square D; Schneider Electric. Subject to compliance with requirements, provide the specified product or a comparable product manufactured by one of the following:
 - 1. Panelboards, Overcurrent Protective Devices, Contactors, and Accessories:
 - a. Eaton Corporation; Cutler-Hammer Products.
 - b. General Electric Co.; Electrical Distribution & Protection Div.
 - c. Siemens Energy & Automation, Inc.

2.2 MANUFACTURED UNITS

- A. Enclosures: Surface-mounted cabinets. NEMA PB 1, Type 4X enclosures.
 - 1. Rated for environmental conditions at installed location.
 - a. Outdoor Locations: NEMA 250, Type 4X.
 - b. Other Wet or Damp Indoor Locations: NEMA 250, Type 4X.
 - c. Front: Secured to box with concealed trim clamps. For surface-mounted fronts, match box dimensions; for flush-mounted fronts, overlap box.
 - 2. Hinged Front Cover: Entire front trim hinged to box and with standard door within hinged trim cover. Note: "Door-in-Door" front covers are also acceptable.
- B. Phase and Ground Buses: Hard-drawn copper, 98 percent conductivity.
- C. Conductor Connectors: Suitable for use with conductor material.
 - 1. Ground Lugs and Bus Configured Terminators: Compression type.
- D. Future Devices: Mounting brackets, bus connections, and necessary appurtenances required for future installation of devices.
- E. Panelboard Short-Circuit Rating:
 - 1. UL label indicating series-connected rating with integral or remote upstream overcurrent protective devices. Include size and type of upstream device allowable, branch devices allowable, and UL series-connected short-circuit rating.
 - 2. Fully rated to interrupt symmetrical short-circuit current available at terminals.

2.3 DISTRIBUTION PANELBOARDS

- A. Doors: Secured with vault-type latch with tumbler lock; keyed alike.
- B. Main Overcurrent Protective Devices: Circuit breaker.
- C. Branch Overcurrent Protective Devices:
 - 1. For Circuit-Breaker Frame Sizes 125 A and Smaller: Plug-in circuit breakers.

2. For Circuit-Breaker Frame Sizes Larger Than 125 A: Plug-in circuit breakers where individual positive-locking device requires mechanical release for removal.
3. Fused switches.

2.4 LIGHTING AND APPLIANCE BRANCH-CIRCUIT PANELBOARDS

- A. Branch Overcurrent Protective Devices: Bolt-on circuit breakers, replaceable without disturbing adjacent units.
- B. Doors: Concealed hinges; secured with flush latch with tumbler lock; keyed alike.

2.5 OVERCURRENT PROTECTIVE DEVICES

- A. Molded-Case Circuit Breaker: UL 489, with series-connected rating to meet available fault currents.
 1. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads, and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
 2. GFCI Circuit Breakers: Single- and two-pole configurations with 30-mA trip sensitivity.
 3. Molded-Case Circuit-Breaker Features and Accessories: Standard frame sizes, trip ratings, and number of poles.
 - a. Lugs: Mechanical style, suitable for number, size, trip ratings, and conductor materials.
 - b. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HACR for heating, air-conditioning, and refrigerating equipment.
- B. Fused Switch: NEMA 4X, Type HD; clips to accommodate specified fuses; lockable handle.
- C. Fuses are specified in Division 26 Section "Fuses."

2.6 ACCESSORY COMPONENTS AND FEATURES

- A. Furnish accessory set including tools and miscellaneous items required for overcurrent protective device test, inspection, maintenance, and operation.
- B. Furnish portable test set to test functions of solid-state trip devices without removal from panelboard.
- C. Fungus Proofing: Permanent fungicidal treatment for panelboard interior, including overcurrent protective devices and other components.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install panelboards and accessories according to NEMA PB 1.1.
- B. Comply with mounting and anchoring requirements published by the manufacturer.
- C. Mount top of trim 72 inches above finished floor, unless otherwise indicated.
- D. Mount plumb and rigid without distortion of box. Mount recessed panelboards with fronts uniformly flush with wall finish.
- E. Install overcurrent protective devices and controllers.
 - 1. Set field-adjustable switches and circuit-breaker trip ranges.
- F. Install filler plates in unused spaces.
- G. Stub three 1-inch empty conduits from panelboard into accessible ceiling space or space designated to be ceiling space in the future. Stub three 1-inch empty conduits into raised floor space or below slab not on grade.
- H. Panelboard Nameplates and Circuit Identification: Label each panelboard with engraved metal or laminated-plastic nameplate mounted with corrosion-resistant screws. Provide a typewritten panel circuit directory to identify the load on each active circuit.
- I. Ground equipment according to Division 26 Section "Grounding".
- J. Connect wiring according to Division 26 Section "Conductors".
- K. Provide multi-pole circuit breakers or approved "handle ties" for multiple single-pole circuit breakers when multi-wire branch circuits are installed, in accordance with NEC Article 210.
- L. Circuit breakers provided as "spares" shall be identified as such, and shall be left in the "off" position at the conclusion of the work.

3.2 FIELD QUALITY CONTROL

- A. Prepare for acceptance tests as follows:
 - 1. Test insulation resistance for each panelboard bus, component, connecting supply, feeder, and control circuit.
 - 2. Test continuity of each circuit.

END OF SECTION 262416

SECTION 262419 - MOTOR CONTROL CENTER

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification Sections, apply to work of this section.

1.2 DESCRIPTION

- A. Provide all labor, material, equipment, tools, and services necessary for, and incidental to, the proper installation of motor control center system and as shown on the Construction Documents.

1.3 QUALITY ASSURANCE

- A. The motor control center shall conform to the requirements of the National Electrical Code (NEC), NEMA, JIC, ANSI, and shall be labeled with the Underwriters Laboratories Seal of Inspection.

1.4 PRODUCT DELIVERY, STORAGE, AND HANDLING

- A. Materials shall be stored to protect them from injury prior to installation. Material should not be stored directly on the ground or floor and shall be kept as clean and dry as possible and free from damage or deteriorating elements.
- B. In general, do not deliver items of electrical equipment to the project substantially before the time of installation. Limit each shipment of bulk and multiple-use materials to the quantities needed for installation within three (3) weeks of receipt.
- C. Deliver products to project properly identified with names, types, grades, compliance labels, and similar information needed for distinct identification. Materials must be adequately packaged or protected to prevent deterioration during shipment, storage, and handling.

PART 2 - PRODUCTS

2.1 MOTOR CONTROL CENTER

- A. Where shown on the Construction Documents, furnish and install NEMA Class 1, Type B, motor control center in NEMA Type 4X enclosure.
- B. The motor control center shall be manufactured to conform to Underwriter's Laboratories Standard No. 845, appropriately UL Labeled and shall conform to NEMA ICS-2 requirements.

- C. The control center will be supplied from a 480 volt, 3 phase, 4 wire, 60 cycle power system, and shall have a short circuit rating as shown on the Construction Documents.
- D. Incoming power feeder shall be cable entering at the top of the section, terminating in a dedicated incoming feed compartment.
- E. Power shall be distributed by means of a continuous horizontal bus with a 600 ampere rating. A ground bus shall be provided.
- F. Combination motor controller and feeder tap units shall employ circuit breaker type motor circuit protectors. If indicated on the Construction Documents, also provide circuit breaker type feeder protection devices.
- G. Unless otherwise shown on the Construction Documents, starter units shall contain:
 - 1. H-O-A selector switch on front cover for each starter.
 - 2. Green running pilot light on front cover for each starter.
 - 3. 120-volt control coils for each starter.
 - 4. Minimum of three (3) melting alloy type overload relays, sized according to NEMA Standards for the motor type, horsepower, and voltage applied. The thermal elements shall be of one-piece construction and interchangeable.
 - 5. Two (2) normal open and two (2) normal closed auxiliary starter interlocks. Ready for control wiring connections in the "automatic" mode.
 - 6. 120-volt control transformer with fuse.
 - 7. Nameplates for each unit.
 - 8. All starters shall be prewired to terminal blocks located in each individual cubicle.
- H. The control center shall consist of vertical sections bolted together to form a unit assembly. A removable lifting angle shall be provided for the assembly. Two (2) removable floor sills shall be provided for mounting.
- I. Wireway compartments for horizontal wiring shall be provided at the top and bottom of the control centers. Incoming line compartment shall be front accessible but isolated from main bus and other compartments. A vertical wiring compartment with a separate hinged front door shall be provided in each controller section.
- J. Each unit compartment shall be provided with an individual front door. Starters and feeder-unit doors shall be interlocked mechanically with the unit disconnect device to prevent unintentional opening on the door while energized and unintentional application of power while door is open. Means shall be provided for releasing the interlock for intentional access to the interior at any time and intentional application of power, if desired, while door is open. Padlocking arrangements shall permit locking and disconnect device off with at least three (3) padlocks with the door closed or open. Unit disconnect operating handle shall be mounted on the disconnect, not on the unit door and shall indicate on and off with door open or closed. Means shall be provided for padlocking the unit in the partially withdrawn position. Overload relays shall be reset from outside the enclosure by means of an insulated bar or button.
- K. Starter units shall be completely drawout Type B, sizes 1 and 2 so that units may be withdrawn without disconnecting any wiring. Sizes 3 and 4 FVNR units shall be drawout type after disconnecting power leads only. Units over three (3) space units

high may be bolt-in type. A positive guidance system shall be provided to assure proper alignment of wedge-shaped power stabs in dead-front openings in vertical power bus. The screw racking mechanism will serve as a mechanical advantage to the operator during unit insertion or removal. Stab-in power terminals shall be of a type that will increase contact pressure on short circuits. Pilot devices shall be mounted on the unit to avoid any necessity for "across-the-hinge" wiring.

- L. The horizontal power bus shall be effectively isolated from all wiring troughs and other working areas. Vertical bus extensions shall be isolated by means of rigid glass polyester moldings in such a manner as to be a separate self-supported assembly. No extra safety jacks or similar devices shall be required to obtain an essentially dead-front condition. Access shall be provided for inspection and maintenance from the front.
- M. All motor starter units shall be for full-voltage, non-reversing (FVNR) motors, unless otherwise noted on the Construction Documents or motor control center schedule.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Mount motor control center on 4" high concrete pad as indicated on the Construction Documents.
- B. Verify all motor ratings and types, and required fuse and overload sizes with the Mechanical Contractor before shipping the motor control center to the site.
- C. Motor control center shall be manufactured by Square D, Siemens, Eaton/Cutler-Hammer, or General Electric.

END OF SECTION 262419

SECTION 262726 - WIRING DEVICES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification Sections, apply to work of this section.

1.2 DESCRIPTION

- A. Provide all labor, materials, equipment, tools, and services necessary for, and incidental to, the proper installation of all wiring devices, such as switches, receptacles, plates, etc., herein specified, and as shown on the Construction Documents.

1.3 QUALITY ASSURANCE

- A. All wiring devices shall conform to the requirements of the National Electrical Code (NEC), NEMA, ANSI, and shall be labeled with the Underwriters Laboratories Seal of Inspection.

1.4 PRODUCT DELIVERY, STORAGE, AND HANDLING

- A. Materials shall be stored to protect them from damage prior to installation. Material should not be stored directly on the ground or floor and shall be kept as clean and dry as possible, and free from damage or deteriorating elements.
- B. Deliver products to project properly identified with names, types, grades, compliance labels and similar information needed for distinct identification. Materials must be adequately packaged or protected to prevent deterioration during shipment, storage, and handling.

1.5 SUBMITTALS

- A. Shop Drawings, if listed in 260010, shall be submitted for all equipment under this Section.

PART 2 - PRODUCTS

2.1 FABRICATION AND MANUFACTURE

- A. Hubbell devices shall be used as a standard of bidding. Equivalent "specification grade" devices as manufactured by Pass & Seymour or Leviton are acceptable. All receptacle and snap switch type devices shall be of one manufacturer.
- B. All receptacles shall be in complete compliance with the latest published NEMA configurations for the intended applications, even though not specifically indicated on

the Construction Documents.

- C. Light switches: 120/277 volt, quiet type, Hubbell #1221 (single pole), #1223 (three-way) and #1224 (four-way).
- D. General Purpose Receptacles: 125 volt, 20 ampere, 2-pole, 3-wire, duplex type, NEMA 5-20R, Hubbell #5362.
- E. GFCI Receptacles: 125 volt, 20 ampere, 2-pole, 3-wire duplex type, NEMA 5-20R, with self-test feature - Hubbell #GFR-5362, feed-thru type capable of protecting downstream circuit devices.
- F. TVSS Receptacles: 125 volt, 20 ampere, 2-pole, 3-wire duplex type, alarm feature, NEMA 5-20R, Hubbell #5362SA (blue).
- G. Tamper Resistant Receptacles: 125 volt, 20 ampere, 2-pole, 3-wire duplex type, NEMA 5-20R, Hubbell #BR20-TR series.
- H. Exterior Receptacles: Provide a GFCI receptacle with a Taymac #MX4380S, metal extra duty "in-use" cover and horizontal mounted box.
- I. Other special purpose devices may be specified on the plans.
- J. All switch and convenience outlet plates shall be satin stainless steel. In unfinished areas utilize cadmium plate round corner steel covers.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. The approximate locations of devices are given on the Construction Documents. The exact location shall be determined at the building as the work progresses. Coordinate with architectural features; also remain clear of all mechanical equipment.
- B. Unless otherwise indicated or otherwise decided at the site, outlet boxes in walls shall be located with center line at elevation above the finished floor as indicated in the symbol legend on the drawings. Also review the architectural elevations and outlet location plans; if dimensions are given, outlets shall be provided with box supports and bracing to allow the installation to the dimensioned locations.
- C. The Owner's Representative shall reserve the right to reasonably change the location of any outlet before it has been installed, without additional charge.
- D. Install light switches on latch side of door, within 6" horizontally of frame edge; confirm latch side of all doors with the General Trades contractor before rough-in.
- E. Install devices above counters 2" to bottom above countertop or backsplash. All devices above any one counter or fixed cabinet - install at same height. Verify locations prior to rough-in.

- F. Install special purpose receptacles, switches, and fixed equipment connections in accordance with Shop Drawings and rough-in drawings furnished by the trades providing such equipment. Verify locations prior to rough-in.
- G. Where receptacles and/or switches are shown within 12" proximity of each other, they shall be installed in multi-gang outlets with suitable multi-gang device plates.
- H. Provide green grounding conductor from each receptacle grounding contact bonded to the outlet box with an approved grounding clip or ground screw connection.
- I. All plates shall suit the device installed. Sectional plates will not be permitted. All flush outlets shall be fitted with device plates that completely conceal the openings.
- J. Install receptacles and switches only in electrical boxes which are clean and free from excess building materials, debris, etc.
- K. At time of substantial completion, replace those wall plates and receptacles which have been damaged during construction.
- L. Wiring devices covered in this section shall be provided with a grounded wire connected to the device and/or the associated outlet box. Test wiring devices to ensure electrical continuity of grounding connections after energizing circuitry to demonstrate compliance with all grounding requirements.
- M. All single pole light switches shall be installed with the "OFF" position down. Outlet boxes shall not be mounted "back-to-back" in stud wall construction.
- N. All GFCI receptacles shall be installed in a readily accessible location, visible for testing and inspection.

END OF SECTION 262726

SECTION 262813 - FUSES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification Sections, apply to work of this section.

1.2 DESCRIPTION

- A. Provide all labor, material, equipment, tools, and services necessary for and incidental to, the proper installation of the fuses and similar overcurrent protective devices for all switches and fusible equipment, including fusible equipment furnished by other trades, herein specified, and as shown on the Construction Documents.

1.3 QUALITY ASSURANCE

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification Sections, apply to work of this section.
- B. All fuses shall conform to the requirements of the National Electrical Code (NEC), NEMA, IEEE, ANSI, and shall be labeled with the Underwriters Laboratories Seal of Inspection: UL 248-10 (Class L), UL 248-12 (Class R) or UL 248-8 (Class J).
- C. Mersen-Ferraz Shawmut Inc. is the basis of design and specification. Equivalent products by Cooper Bussmann or Littelfuse may be provided.

1.4 PRODUCT DELIVERY, STORAGE, AND HANDLING

- A. Materials shall be stored to protect them from damage prior to installation. Materials should not be stored directly on the ground or floor and shall be kept as clean and as dry as possible and free from damage or deteriorating elements.
- B. Deliver products to project properly identified with names, types, grades, compliance labels and similar information needed for distinct identification. Materials must be adequately packaged or protected to prevent deterioration during shipment, storage and handling.

1.5 SUBMITTALS

- A. Contractor may be required to submit fuse coordination curves plotting the time-current characteristic of each type fuse along with fuses in the main service switches all on the graph so that it may be readily determined that proper coordination between the various components of the service and distribution equipment will be attained.
- B. If Contractor substitutes for fuses specified, Contractor shall submit coordination curves as required in Paragraph '1.4.A' above.

- C. All fuses shall be of the same manufacturer to insure retention of selective coordination as designed.

1.6 600 VOLT HIGH-INTERRUPTING CAPACITY FUSES, CURRENT-LIMITING TYPES.

- A. Unless otherwise specified or indicated on the Drawings, all fuses rated 601 through 6000 amperes shall be UL listed Class L. Such fuses shall have a current-limiting threshold of 10 times their current rating or less, and shall have a time-delay of 4 seconds at 5 times their rating: Type A4BQ.
- B. Unless otherwise specified or indicated on the Drawings, all fuses rated 600 amperes or less shall be UL listed, time-delay Class J.
- C. Unless otherwise specified or indicated on the Drawings, all single motor branch circuits shall utilize Type AJT (Class J) fuses sized at 150% (or next standard size) of the National Electrical Code tables, in Article 430.
- D. Transformer primary circuits shall utilize Type TRS-R (Class R 600V) or Type TR-R (Class RK5 250V) fuses sized at 150% of the primary full load current, or next standard size.
- E. Unless otherwise indicated on the Drawings, fuses for branch circuits and feeder circuits shall be:
 - 1. Circuits from 1 ampere through 200 amperes shall be Type AJT (Class J) fuses sized at a minimum 125% of the circuit full load amps and no greater than the conductor rating.
 - 2. Circuits from 225 amperes through 600 amperes shall be Type A4J (Class J) fuses sized at a minimum 125% of the circuit full load amps and no greater than the conductor rating.

PART 2 - EXECUTION

2.1 INSTALLATION

- A. Fuses shall not be installed until equipment is to be energized. Fuses shall be installed with label oriented such that manufacturer's type, catalog number, voltage and current rating can be easily read.

1.1 EXTRA PRODUCT

- A. Spare fuses amounting to 20% (minimum three) of each type and rating shall be supplied by the electrical Contractor. These shall be turned over to the Owner upon project completion.

1.2 FUSIBLE EQUIPMENT

- A. All fusible equipment rated 600 volts or less and 600 amperes or less shall be equipped

to accept only Class J fuses unless specified otherwise.

- B. When fuses protect an individual item of equipment, the equipment nameplate data supersedes fuse sizing suggested in this Section or sizing indicated on the Drawings.

END OF SECTION 262813

SECTION 262816 - SAFETY AND DISCONNECT SWITCHES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification Sections, apply to work of this section.

1.2 DESCRIPTION

- A. Provide all labor, materials, equipment, tools, and services necessary for, and incidental to, the proper installation of the safety and disconnect switches herein specified, and as shown on the Construction Documents.

1.3 QUALITY ASSURANCE

- A. All safety and disconnect switches shall conform to the requirements of the National Electrical Code (NEC), ANSI, and shall be labeled with the Underwriters Laboratories Seal of Inspection.
- B. Safety and disconnect switches shall comply with all requirements of the Regulatory Agencies and shall conform to State Code, Local Codes, and Ordinances.
- C. Integrated equipment rating tests shall be factory performed for rated continuous current, short circuit current, enclosure stability, and dielectric strength.
- D. Reference Section 262813 "Fuses" for proper fuse clip hardware.

1.4 PRODUCT DELIVERY, STORAGE, AND HANDLING

- A. Materials shall be stored to protect them from damage prior to installation. Material should not be stored directly on the ground or floor and shall be kept as clean and dry as possible and free from damage or deteriorating elements.
- B. Deliver products to project properly identified with names, types, grades, compliance labels and similar information needed for distinct identification. Materials must be adequately packaged or protected to prevent deterioration during shipment, storage and handling.
- C. The finished surfaces of switches shall be cleaned to original finish at time of completion of the work.

1.5 SUBMITTALS

- A. Shop Drawings shall be submitted for all equipment provided under this Section. Drawings shall include physical layout showing conduit entrances, lug sizes, lug locations, electrical ratings, and nameplate nomenclature. Manufacturer's written recommendations for storage and protection, installation instructions, and field test requirements shall be provided. Manufacturer's instructions for tightening connections, performing cleaning, and operating and maintenance shall also be included.

PART 2 - PRODUCTS

2.1 FABRICATION AND MANUFACTURE

- A. Safety switches shall be NEMA 4X, heavy duty, enclosed, fused or unfused, of the type, size and electrical characteristics indicated on the Construction Documents.
- B. All switches shall have blades which are fully visible in the "OFF" position when the door is open. Switches shall have removable arc suppressors, where necessary to permit easy access to line-side lugs. Lugs shall be front removable and UL listed for copper cable. All current-carrying parts shall be plated.
- C. Switches shall have quick-make and quick-break operating handles and mechanism which shall be an integral part of the box, not the cover. Padlocking provisions shall be provided for padlocking in the "OFF" position only, with at least three padlocks. The locking provisions shall be such that the padlock directly interferes with the operating handle and is fully visible. Switches shall have a dual cover interlock to prevent unauthorized opening switch door in the "ON" position or closing of the switch mechanism with the door open. Handle position shall indicate if switch is "ON" or "OFF".
- D. Horsepower rated switches shall be provided for motor disconnect application.
- E. Switch enclosure, unless otherwise noted, shall be NEMA Type 4X enclosures.
- F. Switches shall be as manufactured by Square D, Eaton/Cutler-Hammer, Siemens, or General Electric.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install equipment in accordance with manufacturer's written instructions.
- B. Provide all angle iron, channels, supports and hardware required to install equipment. Wall mounted devices shall be mounted with metal "strut" type hardware.

- C. Ground and bond in accordance with the National Electrical Code.
- D. Equipment shall be so installed that the center of the handle will not be more than 72" above the floor or platform.
- E. Provide engraved laminated phenolic plastic nameplate fastened on each switch with self-tapping sheet metal screws.

3.2 ADJUSTMENTS AND CLEANING

- A. At completion of the electrical work, clean out interior of each unit. Clean exterior of units to original finish.
- B. Check all bolted connections to insure that connections are properly installed, contact surfaces are properly mated and bolted connections are properly torqued in accordance with manufacturer's instructions.
- C. Adjust operating mechanisms for free mechanical movement.

END OF SECTION 262816

SECTION 262913 - MOTOR STARTERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification Sections, apply to work of this section.

1.2 DESCRIPTION

- A. Provide all labor, material, equipment, tools and services necessary for, and incidental to, the proper installation of all motor starters herein specified, and as shown on the Construction Documents.

1.3 SUBMITTALS

- A. Shop Drawings shall be submitted for all equipment provided under this Section. Drawings shall include physical layout showing conduit entrances, lug sizes, lug locations, electrical ratings, and nameplate nomenclature. Manufacturer's written recommendations for storage and protection, installation instructions, and field test requirements shall be provided. Certified reports of integrated equipment rating tests shall be provided. Manufacturer's instructions for tightening connections, performing cleaning, and operating and maintenance shall also be included.

1.4 QUALITY ASSURANCE

- A. All motor starters shall conform to the requirements of the National Electrical Code (NEC), NEMA, JIC and ANSI, and shall be labeled with the Underwriters Laboratories Seal of Inspection.
- B. Motor starters shall comply with all requirements of the Regulatory Agencies and shall conform to State Code, Local Codes, and Ordinances.
- C. Integrated equipment rating tests shall be factory performed for rated continuous current, short circuit current, enclosure stability, and dielectric strength.

1.5 PRODUCT, DELIVERY, STORAGE, AND HANDLING

- A. Materials shall be stored to protect them from damage prior to installation. Material shall not be stored directly on the ground or floor and shall be kept as clean and dry as possible and free from damage or deteriorating elements.
- B. Deliver products to project properly identified with names, types, grades, compliance labels and similar information needed for distinct identification. Materials must be adequately packaged or protected to prevent deterioration during shipment, storage and handling.

- C. The finished surfaces of motor starter enclosures shall be cleaned to original finish at time of completion of the work.

PART 2 - PRODUCTS

2.1 FABRICATION AND MANUFACTURE

- A. All motor starters furnished on this project shall be as manufactured by Franklin Control Systems, "BAS" Series, or equal by Square D, ABB or Eaton, unless specifically provided as part of a prepackaged equipment furnished by other Divisions.
- B. Section Includes:
 - 1. Enclosed FVNR combination single phase motor starter with electronic overload relay
 - 2. Enclosed FVNR non-combination motor starters with electronic overload relay
 - 3. Enclosed FVNR combination motor starters with electronic overload relay
 - 4. Enclosed FVNR Two-Speed motor starters with electronic overload relay
- C. The starters referenced in this section are designed and manufactured to the following standards unless otherwise noted:
 - 1. ANSI/NFPA -70, National Electric Code
 - 2. UL 508, and UL508A Industrial Control Equipment
 - 3. NEMA ICS-2, 2000
 - 4. IEC 60947-5, 60947-4, 60947-3
- D. Enclosed Full Voltage Non-Reversing (FVNR) Single Phase Starter
 - 1. Single Phase Motor Starter Control: The 120-volt, single phase motor starter shall consist of a manually operated quick-make toggle mechanism lockable in the "Off" position which shall also function as the motor disconnect. Additionally, the starter shall provide adjustable thermal overload protection, run status pilot light and fault pilot light. The starter must include the capability to operate in both manual and automatic control modes. In automatic mode, the starter shall have the capability to integrate with a building automation system by providing terminals for run input, run status output and fault output. All control terminals shall be integrated in the starter. At a minimum, each single-phase starter shall include an interposing run relay and current sensing status output relay. Single phase motor starter shall be in a surface mount enclosure, Franklin Control Systems, Model BAS-1P or equal by Square D, ABB or Eaton.
- E. Enclosed Full Voltage Non-Reversing (FVNR) Non-Combination, Three Phase Starter
 - 1. Magnetic Motor Starters shall be enclosed in a general purpose electrical enclosure with the appropriate environmental rating.
 - 2. Starters shall consist of a horsepower rated magnetic contactor with a minimum of 2NO and 2NC auxiliary contacts and solid state electronic overload relay. Overload relay shall protect all three phases with a wide range current setting and trip class to allow field adjustment for specific motor FLA. Interchangeable

heater elements are not acceptable. Overload relay shall provide phase failure, phase loss, locked rotor and stall protection.

3. Provide a manual reset pushbutton on the starter cover to restore normal operation after a trip or fault condition.
4. Each starter shall include an installed 100VA control power transformer (CPT) with protected secondary. The CPT must accept the available line voltage and the control voltage shall not exceed 120V.
5. Installed accessories shall include Hand-Off-Auto operation switch with 22mm style operator interfaces. Include LED pilot light indicators for Hand, Off, Auto, Run and Overload conditions. All pilot devices shall be water tight and dust tight.
6. When remotely controlled by an automation system, the starter shall include remote run terminals which accept both a voltage input signal and a contact closure. The voltage run input shall accept both AC and DC signals including 24VAC, 120VAC, 24VDC and 48VDC to allow direct connection of the transistorized automation signal to the starter.
7. In applications where the motor is interlocked with a damper or valve, the actuator control must reside within the starter enclosure. The starter must provide a voltage output to operate the actuator to open the damper or valve without closing the motor circuit. The starter will only close the motor circuit and start the motor after it has received a contact closure from a limit or end switch confirming the damper or valve position.
8. The starter shall provide a provision for Fireman's Override operation. When activated, the starter run the motor in any mode (Hand, Off or Auto) regardless of other inputs or lack of inputs either manual or auto. The purpose of the Fireman's Override input is to act as a smoke purge function. Fireman's Override has priority over the Emergency Shutdown input.
9. If the starter is controlled by a fire alarm or life safety system, the starter shall include an Emergency Shutdown input which will disable the starter from operating in either Hand or Auto mode regardless of other inputs either manual or auto.
10. Manufacturer shall provide and install tags with engraved white lettering to designate equipment served

F. Enclosed Full Voltage Non-Reversing (FVNR) Combination Three Phase Starter

1. Enclosed combination starters shall include all of the magnetic starter requirements in addition to a disconnecting method. Acceptable disconnect is [motor circuit protectors, UL 489 circuit breaker] [fused disconnect]. All disconnects shall include a lock-out mechanism when in the off position.
2. The Motor Circuit protector shall be a UL listed 508 current limiting manual motor starter with magnetic trip elements only. The breaker shall carry a UL 508F rating (up to 100A frame size) which provides for coordinated short circuit rating for use with the motor contactor and provides a minimum interrupting rating of 30,000 AIC for the combination starter. UL 489 breaker shall include thermal and magnetic trip mechanisms.

G. Enclosed Starter Options

1. Must provide over/under voltage and phase monitoring capability. Monitor shall be field adjustable for both over and under voltage levels and a delay time before returning to normal operation after a trip.
 2. Starter must measure and display output current on the front cover. If necessary, install digital or analog ammeter.
 3. The starter shall provide the capability to monitor and calculate power consumption (kWh) of the motor load. Each starter shall display the calculated kW and kWh. Additionally, provide either a pulse output (kWh) or 4-20mA analog signal (kW) to the automation system to monitor the power consumption.
 4. Starter must be capable of communicating over BACnet MS/TP. At a minimum, reported points shall include starter mode, terminal input status, run/fault status, voltage, current, power factor, kW and kWh.
- H. Manufacturer shall provide a five-year warranty on the complete starter assembly and the starter assembly shall be UL listed under UL 508A.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. The appropriate sizes and methods of control of the various motors are shown on the Construction Documents, but this Contractor shall check all sections of these Specifications to determine the exact method of control. Unless noted otherwise, interlock wiring and certain items of control equipment external to the starter enclosure such as mechanical sequence alternators, float switches, pressure switches, etc., will be furnished and wired by other divisions.
- B. Electronic motor overload settings must be consistent with motor load characteristics and motor service factor, as outlined in NFPA 70, Article 430.
- C. Each motor and each item of electrical equipment shall be provided with a disconnect means where required by the National Electrical Code even though not indicated on the Construction Documents. A circuit breaker or horsepower-rated switch in a panel will not be acceptable as a disconnecting means, unless located within sight of the motor controller and arranged to be locked in the open position.
- D. Liquidtight flexible conduit shall be used for all motor final connections. All liquidtight conduit used outdoors or in damp locations shall be galvanized steel flexible tubing with an outer extruded synthetic jacket similar to electrical conduit as manufactured by Anaconda Tubing Company. All conduit fittings used with Sealtite conduit shall be specifically designed for that purpose. Liquidtight conduit shall be used in lengths of not more than 3-feet. Provide equipment grounding wires in all flexible conduit.
- E. Certain pieces of equipment may have motors, starters and controls installed integral with the equipment. Provide electrical service to a location on or near the equipment as indicated, and make all connections. The Contractor shall check the connections of control wiring to various pieces of apparatus in factory wired equipment and shall

check all terminals before equipment or accessories are put into service. Any apparent error or omissions in wiring or connections, or damage to same in transit or erection shall be reported immediately in writing to the Owner's Representative.

- F. Starters shall not be mounted flat against masonry wall or sheet metal housing, but each shall be mounted on not less than two horizontal pieces of Unistrut, Power-Strut or Kindorf-channel iron, or other approved, securely anchored to wall and fastened to framework of enclosure. Where individual starters are installed in a power grouping, the equipment shall be mounted on 3/4" plywood backboard which shall be painted with two (2) coats of light gray enamel. Equipment mounted on structural columns or members shall be supported on an angle or channel iron rack or frame securely bolted or clamped into place. Type of racks, frames, etc., and methods of mounting shall be subject to the approval of the Owner's Representative.
- G. Install equipment in accordance with manufacturer's written instructions.
- H. Provide an angle iron, channels, supports and hardware required to install equipment.
- I. Grounding and bonding in accordance with the National Electrical Code.
- J. Equipment shall be so installed that the center of the disconnect handle will not be more than 72" above the floor or platform.
- K. Provide nameplates fastened on each starter or switch with self-tapping sheet metal screws.

3.2 FIELD QUALITY CONTROL

- A. At completion of the electrical work, clean out interior of each unit. Clean exterior of units to original finish.
- B. Check all bolted connections to insure that connections are properly installed, contact surfaces are properly mated and bolted connections are properly torqued in accordance with manufacturer's instructions.
- C. Adjust operating mechanisms for free mechanical movement.

END OF SECTION 262913

SECTION 310000 - EARTHWORK

PART 1 - GENERAL

1.1 SUMMARY

- A. The Work covered by this Section shall include all excavation, trenching and related work for the construction of the designated structures and pipelines, backfill and other incidental work.
- B. The Work covered by this Section consists of:
 - 1. Making all necessary excavations for the construction of all Work;
 - 2. Preparing subgrade for foundations, slabs, walks, and pavements;
 - 3. Doing all pumping, fluming, and dewatering necessary to keep the trenches and other excavation free from water;
 - 4. Providing for uninterrupted flow of existing drains and sewers, and the disposal of water from any sources during the progress of the Work;
 - 5. Supporting and protecting all trench walls, structures, pipes, conduits, culverts, posts, poles, wires, fences, buildings and other public and private property adjacent to the Work;
 - 6. Removing and replacing existing sewers, culverts, pipelines and bulkheads where necessary;
 - 7. Removing after completion of the Work all sheeting and shoring or other soil support materials not necessary to support the sides of trenches;
 - 8. Removing and disposing all surplus excavated material;
 - 9. Doing all backfilling and grading, of compacting backfill to limits specified or ordered by the Engineer;
 - 10. Restoring all property damaged as a result of the Work involved in this Contract.
- C. The Work includes transporting surplus excavated materials not needed for backfill at the location where the excavation is made, to other parts of the Work where filling is required, and disposal of all types of surplus material off the site.
- D. The Work includes low strength mortar backfill material intended for use in backfilling as shown on the Drawings.

1.2 RELATED DOCUMENTS AND SECTIONS

- A. Section 013319 - Field Testing Requirements
- B. Section 311000 - Dewatering
- C. Section 312100 - Excavation Support and Protection

- D. Section 312514.16 - Erosion Control Matting
- E. Section 030000 - Concrete Work
- F. Specific Project Requirements
- G. Geotechnical Reports

1.3 DEFINITIONS

- A. Backfill: Soil or granular materials used to fill an excavation.
 - 1. Initial Backfill: Backfill placed beside and over pipe in a trench, not including haunches to support sides of pipe.
 - 2. Final Backfill: Backfill placed over initial backfill to fill a trench.
- B. Bedding: Layer placed over the excavated subgrade in a trench before laying pipe.
- C. Borrow: Satisfactory soil imported for use as fill or backfill.
- D. Excavation: Removal and disposal of material encountered above subgrade or foundation elevations.
 - 1. Additional Excavation: Excavation below subgrade or foundation elevations as directed by Engineer.
 - 2. Trench: Narrow linear excavation
 - 3. Unauthorized Excavation: Excavation below subgrade or foundation elevations or beyond indicated dimensions without direction by Engineer. Unauthorized excavation, as well as remedial work directed by Engineer, shall be without additional compensation.
 - 4. Unclassified Excavation: Excavation to subgrade elevations regardless of the character of surface or subsurface conditions encountered, including rock, soil materials and obstructions.
- E. Embankment: A structure consisting of soil, granular material, shale, rock, or other approved material, constructed in layers to a predetermined elevation and cross-section.
- F. Granular materials: Natural aggregate, such as broken or crushed rock, gravel, or sand that can be readily incorporated into an 8-inch layer, and in which at least 65% by weight of the grains or particles are retained in a No. 200 sieve.
- G. Laboratory Dry Weight: The maximum laboratory dry weight shall be the weight provided by the laboratory when the sample is tested in accordance with ASTM D-698 Method A, C, or D.
- H. Optimum Moisture: The water content at which the maximum density is produced in a soil by a given compaction effort (ASTM D-698).

- I. Pavement Prism: Also referred to as the zone of influence. The area below a line drawn 45 degrees to the horizontal from the surface at the edge of pavement, sidewalk or curb.
- J. Pipe Embedment: The material placed in a trench surrounding a pipe or conduit consisting of the foundation, bedding, haunching, and initial backfill.
- K. Rock: Rock material in beds, ledges, unstratified masses, and conglomerate deposits and boulders of rock material one (1) cu. yd. or more in volume that when tested by an independent geotechnical testing agency, according to ASTM D 1586, exceeds a standard penetration resistance of 100 blows/2 inches.
- L. Shale: Laminated material, formed by the consolidation in nature of soil, having a finely stratified structure. For the purpose of these specifications, the following bedrock types shall also be considered shale: mudstone, claystone, siltstone and hard clay.
- M. Soil: All earth materials, organic or inorganic, which have resulted from natural processes such as weathering, decay, and chemical reaction.
- N. Structures: Buildings, footings, foundations, retaining walls, slabs, tanks, curbs, pavement, mechanical and electrical appurtenances, or other man-made stationary features constructed above or below the ground surface.
- O. Subgrade: Surface or elevation remaining after completing excavation, or top surface of a fill or backfill immediately below subbase, drainage course, or topsoil materials.
- P. Utilities: On-site underground pipes, conduits, ducts, and cables, as well as underground services within buildings.

1.4 SUBMITTALS

- A. Comply with all provisions of Section 013323, Shop Drawings and Submittals.
- B. Product Data: For the following:
 - 1. Source-locations of all materials shall be identified to the Engineer.
 - 2. Source quality laboratory test of all fill materials as required to show compliance with material specifications.
 - 3. Manufacturer's specifications with application and installation instructions for proprietary materials and items, including admixtures to be used in pervious concrete mixes and CDF mixes.
 - a. Submit a sieve analysis and a proctor test report for Select Fill, CDF III,
 - b. and Pipe bedding material.
- C. Shop Drawings: Submit information for the following items:
 - 1. List of CDF materials and mix designs proposed for use. Include results of quality assurance testing performed to qualify the materials and to establish the mix designs.
 - 2. Laboratory Trial Batch Reports: Submit laboratory quality assurance test reports for materials and mix design tests.

3. Modifications to the Work proposed due to design of sheeting, shoring, bracing, cofferdams, and similar excavation supports.
4. Sheeting and bracing (prepared and stamped by a professional engineer, registered in the State of Ohio).

D. Informational Submittal, submit for acceptance, the following:

1. Procedure Submittals:
 - a. Proposed compaction procedure and compaction equipment proposed for use. Where different procedures or equipment will be used for compacting different types of material or at different locations at the Site, indicate where each procedure and equipment item will be used.
 - b. Dewatering system.
2. Delivery Tickets:
 - a. Copies of delivery tickets for each load of pervious concrete and CDF material delivered to or mixed at the Site. Each delivery ticket shall contain information in accordance with ASTM C94/C94M along with project and contract name and number, date, mix type, mix time, quantity and amount of water introduced.
 - b. Copy of delivery ticket for each load of aggregate and borrow material delivered to the Site. Each delivery ticket shall indicate project and contract by name and number, date, material type, department of transportation item number when applicable, and quantity delivered.
3. Quality Assurance Test Results Submittals:
 - a. Submit results of quality assurance testing performed by in accordance with Paragraph 1.4.C. of this Section, unless included as part of another submittal under this Section. Submit results for the following quality assurance testing:
 - 1) Tests on borrow fill material.
 - 2) Optimum moisture – maximum dry density curve for each type of fill material.
4. Field Quality Control Submittals:
 - a. Submit results of testing and inspection performed in accordance with the field quality control Article in Part 3 of this Section, including:
 - 1) Field density testing.
5. Qualifications Statements:
 - a. Quality Assurance Testing laboratory. Submit name and qualifications of testing laboratory to be employed, and qualifications of testing laboratory's personnel that will perform quality assurance testing required in this Section if different than OWNER's testing laboratory

1.5 REFERENCES

- A. AASHTO M 43 Standard Specification for Size of Aggregate for Road and Bridge Construction
- B. ASTM C-150 Standard Specification for Portland Cement

- C. ASTM C-618 Standard Specification for Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Portland Cement Concrete
- D. ASTM D-698 Standard Test Methods for Moisture-Density Relations of Soils and Soil-Aggregate Mixtures Using 5.5-lb (2.49-kg) Rammer and 12-in. (305-mm) Drop
- E. ASTM D-1586 Standard Method for Penetration Test and Split-Barrel Sampling of Soils
- F. ASTM D-2487 Standard Test Method for Classification of Soils for Engineering Purposes
- G. ASTM D-2940 Standard Specification for Graded Aggregate Material for Bases or Subbases for Highways or Airports
- H. ASTM D-4253 Standard Test Method for Maximum Index Density and Unit Weight of Soils Using a Vibratory Table
- I. ASTM D-4254 Standard Test Method for Minimum Index Density and Unit Weight of Soils and Calculation of Relative Density
- J. State of Ohio - Department of Transportation - Construction and Material Specifications, Item 304, Aggregate Base.
- K. State of Ohio - Department of Transportation - Construction and Material Specifications, Material Detail 703.16, Suitable Materials for Embankment Construction.
- L. State of Ohio - Department of Transportation - Construction and Material Specifications, Material Detail 703.02.A.2, Fine Aggregate for Portland Cement Concrete

1.6 QUALITY ASSURANCE

A. Qualifications

- 1. CONTRACTOR's Testing Laboratory:
 - a. Retain the services of independent testing laboratory to perform testing
 - b. and determine compliance with the Contract Documents of the materials
 - c. specified in this Section.
 - d. Testing laboratory shall comply with ASTM E329.
 - e. Testing laboratory shall be experienced in the types of testing required.
 - f. Selection of testing laboratory is subject to ENGINEER's acceptance.

B. Regulatory Requirements:

- 1. Reference Specifications and Details:
 - a. Comply with applicable requirements of 2019 State of Ohio Department of Transportation Construction and Material Specifications.

C. Quality of Assurance Testing:

- 1. Quality assurance testing is in addition to field quality control testing required under Part 3 of this Section.

2. Materials used in the Work may require testing and retesting, as directed by ENGINEER, during the Project. Allow free access to material stockpiles and facilities at all times. Tests not specifically indicated to be performed at OWNER's expense, including retesting of rejected materials and installed Work, shall be performed at CONTRACTOR's expense.
3. CONTRACTOR's Testing Laboratory Scope:
 - a. Collect samples and perform testing of proposed fill materials in the laboratory and in the field to demonstrate compliance of the Work with the Contract Documents.
 - b. Testing laboratory shall perform testing required to obtain data for selecting moisture content for placing and compacting fill materials.
 - c. Design controlled density fill (CDF) mixes in accordance with requirements of ODOT Item 613. Perform concrete materials evaluation tests and testing of CDF mixes.
 - d. Submit to ENGINEER and CONTRACTOR written report results of each test.
4. Required Quality Assurance Material Testing by CONTRACTOR's Testing:
 - a. Gradation in accordance with ASTM D422. Perform one test for every 1,000 cubic yards of each of the following types of material incorporated into the Work: select fill, CDF III, and pipe bedding material.
 - b. Atterberg limits in accordance with ASTM D4318. Perform one test for every 1,000 cubic yards of the following types of materials incorporated into the Work: pipe bedding material.
 - c. Moisture/density relations in accordance with ASTM D698, ASTM D1557, ASTM D4253, or ASTM D4254, as applicable. Perform one test for every 5,000 cubic yards of the following types of materials incorporated into the Work: select fill, CDF III, and pipe bedding material.
 - d. Moisture content of stockpiled or borrow material in accordance with ASTM D2216. Perform one test for every 1,000 cubic yards of the following types of material incorporated into the Work: select fill, CDF III, and pipe bedding material.
 - e. CDF Mix: Verify CDF mix design by laboratory trial batch, in accordance with ODOT Item 613.
 - 1) Submit for each concrete mix trial batch the following information:
 - a) Project identification name and number (if applicable).
 - b) Date of test report.
 - c) Complete identification of aggregate source of supply.
 - d) Tests of aggregates for compliance with the Contract Documents.
 - e) Brand, type, and composition of cementitious materials.
 - f) Brand, type, and quantity of each admixture.
 - g) Quantity of water used in trial mixes.
 - h) Proportions of each material per cubic yard.
 - i) Gross weight and yield per cubic yard of trial mixtures.
 - j) Measured flowability.
 - k) Measured air content.
 - l) Unconfined compressive strength.

A. Regulatory Requirements:

1. Perform excavation work in compliance with requirements of authorities having jurisdiction and Laws and Regulations, including:
 - a. OSHA, 29 CFR Part 1926, Section .650 (Subpart P – Excavations).
2. Obtain required permits and approvals for excavation and fill Work, including work permits from right-of-way owners and permits from environmental authorities having jurisdiction over discharge of water from excavations.

1.6 PROJECT CONDITIONS

- A. Subsurface Information: The Supplementary Conditions indicate information available relative to subsurface conditions at the Site. Such information and data is not intended as a representation or warranty of continuity of conditions between soil borings or test pits, nor of groundwater levels at dates and times other than date and time when measured, nor that purpose of obtaining the information and data were appropriate for use by CONTRACTOR. OWNER will not be responsible for interpretations or conclusions drawn therefrom by CONTRACTOR.
- B. Soil borings and other exploratory operations may be made by CONTRACTOR, at no additional cost to OWNER. Coordinate CONTRACTOR-performed test borings and other exploratory operations with OWNER and utility owners as appropriate. Perform such explorations without disrupting or otherwise adversely affecting operations of OWNER or utility owners. Comply with Laws and Regulations relative to required notifications.
- C. Existing Conditions
 1. Existing ground elevations of the site are shown by figures and/or by contours on the Drawings. The contours and elevations of the present ground are believed to be reasonably correct, but do not purport to be absolutely so, and, together with any schedule of quantities, are presented only as an approximation. The Contractor shall satisfy himself, however, by actual examination on the site of the Work, as to the existing elevations and contours, and the amount of work required.
- D. Existing Utilities
 1. Coordinate with utility owners for shut-off of services in active piping and conduits. When required by utility owner, OWNER will assist CONTRACTOR with utility owner notifications. Completely remove buried piping and conduits indicated for removal and not otherwise indicated as being abandoned or to remain in place.
 2. Do not interrupt utilities serving facilities occupied by Owner or others unless permitted in writing by Engineer and then only after arranging to provide temporary utility services according to requirements indicated.
 3. Notify Engineer not less than two days in advance of proposed utility interruptions.
 4. Do not proceed with utility interruptions without Engineer's written permission.
 5. Contact utility-locator service for area where Project is located before excavating.

1.7 DELIVERY, STORAGE AND HANDLING

- A. Deliver products to the site, store and protect under provisions of Section 016600, Product Handling and Protection.

1.8 SEQUENCING AND SCHEDULING

- A. Refer to 013319.01, Field Test and Reporting.

1.9 PROHIBITION OF EXPLOSIVES

- A. The use of explosives is not permitted.

1.10 FIELD MEASUREMENTS

- A. The Contract Drawings may indicate locations where certain utilities, structures or facilities might possibly interfere with the installation of new improvements. The Contractor shall dig such exploratory test pits as may be necessary to determine the exact location and elevation of the indicated subsurface structure and shall make acceptable provision for their protection, support and maintenance in operation.
- B. The Engineer shall be provided advance notification when and where excavation for test pits will take place. The Contractor shall provide the Engineer a record of field locations of all listed utilities, structures or facilities a minimum of five (5) days prior to initiating construction of the project. Locations and elevations are to be provided by a Surveyor registered in the State of Ohio.

PART 2 - PRODUCTS

2.1 GRANULAR PIPE EMBEDMENT

- A. Crushed gravel or crushed limestone meeting AASHTO M 43 gradation shall be used for bedding, haunching, and initial backfill as shown on the Drawings.

2.2 SAND PIPE EMBEDMENT

- A. Fine aggregate consisting of natural sand meeting the gradation requirements of ODOT Item 703.02.A.2 or shown on the Drawings. The material shall not be lumpy or frozen, and shall be free from slag, cinders, ashes, rubbish, and other deleterious or objectionable material. Sand shall not contain a total of more than 10% by weight of loam and clay.

2.3 ONSITE BACKFILL

- A. Excavated soil material, capable of meeting specified compaction, and approved by the Engineer for use as backfill in designated locations.
- B. Based upon subsurface investigation, the Owner does not guarantee the onsite soils in its present state consists of the proper moisture content to achieve the specified compaction without drying or adding water.

C. Unsuitable Backfill Material

1. Onsite materials that are unsuitable for backfill, unless otherwise specifically shown in the Drawings, include rock or other materials greater than six (6) inches in their largest dimension, pavement, rubbish, debris, wood, metal, plastic, frozen earth, and the following soils classified per ASTM D-2487:

Symbol	Description
OL	Organic silts and organic silty clays of low plasticity
MH	Inorganic silts, micaceous or diatomaceous fine sands or silts, elastic silts
CH	Inorganic clays of high plasticity, fat clays
OH	Organic clays of medium to high plasticity
PT	Peat, muck, and other highly organic soils

2.4 SPECIAL BACKFILL MATERIAL (ODOT Item 304)

- A. Special backfill material shall meet the gradation requirements of ODOT Item 304 and shall consist of crushed gravel or crushed limestone in combination with natural sand or stone. The aggregate shall meet the following gradation requirements:

Sieve	Total Percent Passing
2 inch	100
1 inch	70-100
3/4-inch	50-90
No. 4	30-60
No. 40	9-33
No. 200	0-15

2.5 LOW STRENGTH MORTAR BACKFILL

- A. Cement shall conform to ASTM C-150, Type 1
- B. Fly ash shall be Class F, ASTM C-618.
- C. Aggregate
 1. Fine Aggregate shall be natural sand consisting of mineral aggregate particles. The gradation of the sand shall be as follows:

Sieve Size	Percent Passing
3/4"	100
200	0 - 10

2. It is intended that the sand be fine enough to stay in suspension in the mixture to the extent required for proper flow. The Engineer reserves the right to reject the sand if a flowable mixture cannot be produced.

D. Mortar Mix Proportioning

1. The initial trial mixture shall be as follows:

Quantity of Dry Materials per Cubic Yard

Cement	100 lbs.
Fly Ash	250 lbs.
Sand (SSD)*	2700 lbs.
Water	500 lbs.

* saturated-surface dry

2. These quantities of materials are expected to yield approximately 1 cubic yard of mortar of the proper consistency. Adjustments of the proportions may be made providing the total absolute volume of the materials is maintained.

2.6 ACCESSORIES

A. Warning Tape

1. Acid- and alkali-resistant polyethylene film warning tape manufactured for marking and identifying underground utilities, 6 inches wide and 4 mils thick, continuously inscribed with a description of the utility; colored as follows:
 - a. Red: Electric.
 - b. Yellow: Gas, oil, steam, and dangerous materials.
 - c. Orange: Telephone and other communications.
 - d. Blue: Water systems.
 - e. Green: Sewer systems.

B. Detectable Warning Tape

1. Acid- and alkali-resistant polyethylene film warning tape manufactured for marking and identifying underground utilities, a minimum of 6 inches wide and 4 mils thick, continuously inscribed with a description of the utility, with metallic core encased in a protective jacket for corrosion protection, detectable by metal detector when tape is buried up to 30 inches deep; colored as follows:
 - a. Red: Electric.
 - b. Yellow: Gas, oil, steam, and dangerous materials.
 - c. Orange: Telephone and other communications.
 - d. Blue: Water systems.
 - e. Green: Sewer systems.

PART 3 - EXECUTION

3.1 PROTECTION

A. Excavation; Temporary Sheeting, Shoring, and Bracing

1. All excavation shall be in accordance with the Occupation Safety and Health Administration (OSHA) regulations.
2. The Contractor shall furnish and install adequate sheeting, shoring, and bracing to maintain safe working conditions, and to protect newly built work and all adjacent neighboring structures from damage by settlement.

3. Bracing shall be arranged so as not to place a strain on portions of completed work until construction has proceeded enough to provide ample strength. Sheeting and bracing may be withdrawn and removed at the time of backfilling, but the Contractor shall be responsible for all damage to newly built work and adjacent and neighboring structures.
4. All sheeting shall be removed unless specifically authorized in writing by the Engineer to be left in place.

B. Construction Sheeting Left in Place

1. The Contractor shall furnish, install, and leave in place construction sheeting and bracing when specified or when indicated or shown on the Drawings.
2. Any construction sheeting and bracing which the Contractor has placed to facilitate his work may be ordered in writing by the Engineer to be left in place. The right of the Engineer to order sheeting and bracing left in place shall not be construed as creating an obligation on his part to issue such orders. Failure of the Engineer to order sheeting and bracing left in place shall not relieve the Contractor of his responsibility under this Contract.

3.2 REPLACING, MOVING AND REPAIRING OF EXISTING UTILITIES

A. The Contractor shall:

1. Replace, move, repair and maintain all utilities and all other structures encountered in the work
2. Coordinate and communicate with applicable utility companies
3. Repair all damage done to any of the said structures and appurtenances through his acts or neglect and shall keep them in repair during the life of this contract. The Contractor shall in all cases leave them in as good condition as they were previous to the commencement of the work and to the satisfaction of the Engineer.

3.3 DEWATERING

A. Drainage and Removal of Water

1. The Contractor shall dispose of water from the Work in a suitable manner without damage to adjacent property or structures.
2. The Contractor shall, when ordered by the Engineer, construct tight bulkheads across trench and provide pumps suitable for the removal of any water which may be encountered or which may accumulate in the trenches. Unless otherwise provided for in the Contract Documents, drainage water will not be permitted to flow through the conduit.
3. The trench shall be kept free from sewage and storm, surface, and subsurface water to at least 2 feet below the bottom of the excavation.
4. Where open water courses, ditches, or drain pipes are encountered during the progress of the Work, the Contractor shall provide protection and securing of the

continuous flow in such courses or drains and shall repair any damage that may be done to them.

3.4 EXCAVATION CLASSIFICATION

- A. All excavated materials are unclassified as defined in Article 1.3.

3.5 GENERAL EXCAVATION

- A. All necessary excavation for buildings, structures, pavements, and site improvements shall be performed to accommodate the completion of all related Contract Work.
- B. The Drawings show the horizontal and the lower limits of structures. The methods and equipment used by the Contractor when approaching the bottom limits of excavation shall be selected to provide a smooth surface and to prevent disturbing the soil below the bottom limits of excavation. All soil loosened during excavation shall be removed from the bottom of the excavation.
- C. Conform to elevations and dimensions shown within a tolerance of plus or minus 0.10 feet, and extending a sufficient distance from footings and foundations to permit placing and removal of concrete formwork, installation of services, other construction, and for inspection.
- D. Excavation which is carried below the bottom limits of structures shall be classified as Unauthorized Excavation, unless said excavation below bottom limits of structures has been authorized by the Engineer prior to each occurrence.
- E. Unauthorized Excavation shall be filled with Class B concrete to the bottom limits of structures. Under circumstances where structural integrity is not a factor, the Engineer may authorize the filling of Unauthorized Excavation with Low Strength Mortar Backfill or Special Backfill material compacted to 100% density as specified under the compaction requirements in this Section. Such work shall be at the cost of the Contractor.

3.6 TRENCH EXCAVATION

- A. Excavation for trenches in which pipelines, sewers, and conduits are to be installed shall provide adequate space for workmen to space and joint pipe properly, but in every case the trench shall be kept to a minimum width. The width of trench shall not exceed the limits shown on the Drawings.
- B. Excavation shall be to the depth necessary for placing of granular bedding material under the pipe as shown on the Drawings. If over-excavation occurs, the trench bottom shall be filled to grade with compacted granular bedding material.
- C. Trenching operations shall not be performed beyond the distance that will be backfilled and compacted the same day.
- D. In general, backfilling shall begin as soon as the conduit is in approved condition to receive it and shall be carried to completion as rapidly as possible. New trenching shall

not be started when earlier trenches need backfilling or the surfaces of streets or other areas need to be restored to a safe and proper condition.

3.7 EXCAVATION OF UNSUITABLE MATERIALS

- A. Unsuitable materials existing below the Contract bottom limits for excavation shall be removed as directed by the Engineer. Such excavation shall not exceed the vertical and lateral limits as prescribed by the Engineer.
- B. In utility trenches, the voids left by removal of unsuitable excavated material shall be filled with AASHTO M 43 No. 1 and No. 2 aggregate conforming to the material requirements of Article 2.1 of this Section.
- C. In excavations other than utility trenches, the voids left by removal of unsuitable excavated material shall be filled with material consisting of either: (1) Special Backfill Material; (2) Class B concrete; or (3) Low Strength Mortar Backfill, whichever is ordered by the Engineer.
- D. Removal of unsuitable excavated material and its replacement as directed will be paid on basis of Contract Conditions relative to Changes in Work unless specific unit prices have been established for excavation of unsuitable material.

3.8 DISPOSAL OF UNSUITABLE AND SURPLUS MATERIAL

- A. It shall be the responsibility of the Contractor to dispose of all surplus material that cannot be used in backfill or embankments at his expense outside the limits of the project. Unsuitable excavated material, including rock or large boulders, shall be disposed of outside the limits of the project.
- B. Surplus material may be wasted adjacent to or incorporated in the regular construction only when ordered in writing by the Engineer.
- C. Disposal of materials shall be in compliance with Laws and Regulations, at no additional cost to OWNER.

3.9 BACKFILL

- A. Pipelines, Sewers and Conduits
 - 1. All pipe shall have bedding extending the width of the trench with depth in conformance with the Drawings. The bedding material shall be thoroughly compacted by tamping until no further densification is possible.
 - 2. Pipe cover material shall be used for filling above the pipe bedding along the sides of the pipe and to a height of twelve (12) inches over the top of the pipe. The pipe cover material shall be brought up evenly on both sides of the pipe to eliminate the possibility of lateral displacement of the pipe and shall be thoroughly compacted by tamping until no further densification is possible. Care shall be taken to spade the aggregate under the pipe haunch below the spring line.

3. All trenches and excavations shall be backfilled immediately after pipe is laid therein, unless otherwise directed by the Engineer.
4. After the pipe cover has been placed and compacted around the pipe as specified above, the remainder of the trench may be backfilled by machine. The backfill material shall be deposited in eight (8) inch horizontal layers, and each layer shall be thoroughly compacted to the specified density by approved methods before a succeeding layer is placed. In no case will backfilling material from a bucket be allowed to fall directly on a pipe and in all cases the bucket must be lowered so that the shock of the falling earth will not cause damage.
5. Puddling of sand bedding and pipe cover material is acceptable provided an acceptable method for removal of water is provided.

B. Structures

1. Backfilling shall not commence before concrete has attained specified strength. Do not use equipment for backfilling and compaction operations against structures that will overload the structure.
2. Backfilling around and over structures shall be carefully placed and tamped with tools of suitable weight to a point one (1) foot above the top of same. Additional backfill may be required to protect the structure from damage from heavy equipment. Backfill shall be placed in uniform layers not exceeding eight (8) inches in depth. Each layer shall be placed, then carefully and uniformly compacted to the specified density so as to eliminate the possibility of displacement of the structure.
3. After the backfill has been placed and compacted around the structure to the height specified above, the remainder may be backfilled by machine. The backfill material shall be deposited in eight (8) inch horizontal layers, and each layer shall be thoroughly compacted to the specified density by approved methods before a succeeding layer is placed.
4. In no case will backfilling material from a bucket be allowed to fall directly on a structure, and in all cases the bucket must be lowered so that the shock of the falling earth will not cause damage.

C. Where any new, proposed, or future pavement, driveway, parking lot, curb, curb and gutter, or walk is to be placed over a backfilled area, Special Backfill material shall be used for any portion of the trench falling within the pavement prism.

D. Where it is necessary to undercut or replace existing utility conduits and/or service lines, the excavation beneath such lines shall be backfilled the entire length with approved Granular Pipe Embedment Material compacted in place in eight (8) inch layers to the required density. The approved Granular Pipe Embedment Material shall extend outward from the spring line of the conduit a distance of two (2) feet on either side and thence downward at its natural slope.

3.10 LOW STRENGTH MORTAR BACKFILL

- A. Low strength mortar backfill shall be discharged from the mixer as recommended by the supplier and approved by the Engineer.
- B. Low strength mortar backfill may be placed in the trench in as few lifts as may be practical.
- C. Secure conduit or pipelines before placing low strength mortar backfill to prevent conduits and pipelines from floating during backfilling.
- D. For low strength mortar backfill placed against existing structures of unknown strength, backfill material shall be brought up uniformly in maximum 12 inch lifts and allowed to cure for a minimum of 24 hours or until it can carry a person's weight without leaving imprints before the next lift is placed.
- E. Low strength mortar backfill shall be brought up to subgrade elevation or the pavement prism, whichever may be applicable.

3.11 SUBGRADE

- A. All soil subgrade shall be prepared in accordance with this subsection.
- B. Drainage
 - 1. The surface of the subgrade shall be maintained in a smooth condition to prevent ponding of water after rains to insure the thorough drainage of the subgrade surface at all times.
- C. Unsuitable Subgrade
 - 1. Where unsuitable subgrade or subgrade not meeting the required bearing capacity is encountered in cuts, due to no fault or neglect of the Contractor, in which satisfactory stability cannot be obtained by moisture control and compaction, the unstable material shall be excavated to the depth required by the Engineer.
 - 2. Suitable material required for the embankment to replace the undercut will be paid on basis of Contract Conditions relative to changes in Work.
 - 3. Where soft subgrade in cuts is due to the failure of the Contractor to maintain adequate surface drainage as required in this article, or is due to any other fault or neglect of the Contractor, the unstable condition shall be corrected as outlined above at no expense to the Owner.
- D. Full Width New Pavement Construction
 - 1. After the surface of the subgrade has been shaped to approximate cross section grade, and before any pavement, base or subbase material is placed thereon, the subgrade shall be compacted. When the rolling is completed, all surface irregularities shall be corrected and the surface of the subgrade shall be shaped as necessary to conform to the grade and cross section shown on the Drawings within the tolerance set forth in this Section and shall be so maintained until the overlying course is in place.

3.12 TOLERANCES

- A. The Contractor shall check the work under this item with templates, slope boards or other devices satisfactory to the Engineer. The completed work shall conform to the Drawings within the following tolerances:
 - 1. For subgrade, the surface shall at no place vary more than 1/2-inch from a ten-foot straight edge applied to the surface parallel to the centerline of the pavement, nor more than 1/2-inch from subgrade elevation established by construction layout stakes.

3.13 CONSTRUCTION WITH MOISTURE AND DENSITY CONTROL

- A. All backfill, shall be constructed using moisture and density control. All subgrade, except rock and shale in cut sections, shall be constructed using moisture and density control.
- B. Backfill and subgrade material which does not contain sufficient moisture to be compacted in accordance with the requirements of Article 3.15 of this Section shall be sprinkled with water as directed by the Engineer to bring the moisture content to within the range of optimum plus or minus two (2) percent. Water shall be thoroughly incorporated into the material by means of discs or other approved equipment.
- C. Backfill and subgrade material containing excess moisture shall be dried, prior to installation, to a moisture content not greater than two (2) percentage points above optimum, except that for material within the moisture content range specified herein that displays pronounced elasticity or deformation under the action of loaded construction equipment, the moisture content shall be reduced to optimum or below if necessary to secure stability. For subgrade material, these requirements for maximum moisture shall apply at the time of compaction of the subgrade and also at the time of placing pavement or subbase. Drying of wet soil shall be expedited by the use of plows, discs, or by other approved methods when so ordered by the Engineer.

3.14 PROOF ROLLING

- A. Proof rolling shall be performed on areas described on the Drawings or as directed by the Engineer.
- B. Proof rolling equipment shall consist of a single unit, tandem axle dump truck capable of being loaded to 30,000 pound axle load with a gross vehicle weight of 60,000 pounds. Tire pressure shall be maintained at 90 psi. Loading shall be verified by a certified weight slip.
- C. Procedure
 - 1. The designated areas of subgrade, prior to the placing of the overlying course, shall be compacted to requirement of this Section. The Contractor shall be responsible for performing a minimum of two (2) proof rollings of the subgrade, as directed by the Engineer, prior to paving. The first proof rolling shall be performed after the installation of underground improvements and rough grading has been completed. After fine grading and just prior to paving, the subgrade shall be proof rolled again.

The proof roller shall operate in a systematic manner so that the number of coverages over all areas can be readily determined and recorded. Maximum spacing shall not exceed six (6) feet.

2. Moisture content of the subgrade at the time of proof rolling shall conform to the requirements of this Section.
3. The equipment shall be operated at the speed directed, but in no case shall the speed exceed five (5) miles per hour, and the normal operating speed shall not be less than two (2) miles per hour.
4. Where the operation of the proof roller shows the subgrade to be unstable or to have non-uniform stability, the Contractor shall correct the unstable areas so that the stability of the subgrade will be uniform and satisfactory. The subgrade shall then be checked for conformance to the plan lines and any irregularities of the surface caused by operation of the proof roller shall be corrected and the subgrade shall be shaped to the plan lines within the tolerances specified in this Section.
5. The proof roll is a subjective test and does not relieve the Contractor of his responsibility under the Contract to provide an acceptable subgrade.
6. If the subgrade fails due to the Contractor using it as a haul road or due to his negligence, the subgrade shall be repaired, retested, and proof rolled again at no additional cost to the Owner.

3.15 COMPACTION REQUIREMENTS

- A. The bottom of excavations upon which concrete foundations or structures are to be placed shall be compacted so as to obtain 100% of maximum dry density per ASTM D-698 in the top twelve (12) inches.
- B. The top twelve (12) inches of stripped original subgrade and final subgrade shall be compacted to not less than 100% of maximum dry density per ASTM D-698.
 1. Subgrade under new, proposed, or future pavement shall be compacted 18 inches beyond the edge of pavement, paved shoulders or paved medians.
- C. Compaction of subgrade for sidewalks (regardless of paving material) shall be 100% of maximum dry density per ASTM D-698 in the top six (6) inches.
- D. Compaction of non-paved areas shall be 90% of maximum dry density per ASTM D-698.
- E. Aggregate pipe embedment and aggregate backfill around structures shall be compacted to not less than 100% of maximum dry density per ASTM D-4253 and ASTM D-4254.
- F. Final backfill shall be compacted to not less than 100% of maximum dry density per ASTM D-698.
- G. Fill placed within the interior of structures shall be compacted to not less than 100% of maximum dry density per ASTM D-698.

- H. Embankment shall be placed and compacted in layers until the density is not less than the percentage of maximum dry density indicated in the following table determined by ASTM D-698.

EMBANKMENT SOIL COMPACTION REQUIREMENTS

Maximum Laboratory Dry Weight <u>Pounds/Cubic Foot</u>	Minimum Compaction Requirements Percent Laboratory <u>Maximum</u>
90-104.9	102
105-119.9	100
120 and more	98

I. Test Sections

1. If it is determined by the Engineer that the composition of the material is such that it cannot be tested for density using a nuclear densometer or other methods; or where, in the opinion of the Engineer, in-place compaction testing is not feasible; and if approved by the Engineer, the Contractor may construct a test section to demonstrate acceptable compactive effort in lieu of in-place compaction testing. Test sections shall be constructed at no additional cost to the Owner.
2. The test section shall be completed by repeatedly compacting the material until no further density is achieved. This value shall be the Minimum Test Section Density (MTSD). The compaction equipment used to complete the test section shall be of suitable size to compact the material and shall be the same equipment used to compact the in-place material.
3. The test section shall be constructed with moisture density control as specified in this Section.
4. The material shall be compacted to at least 98% of the MTSD.
5. Each lift of in-place fill or backfill shall be densified using a compactive effort equal to or greater than the effort applied to achieve the MTSD; i.e., if six passes were required to achieve MTSD, then each lift of material shall be compacted using six or more passes.
6. Construct a new test section when, in the opinion of the Engineer, the fill or backfill material has changed character or when the supporting material has changed character.

3.16 GRADING

- A. Uniformly grade areas to a smooth surface, free of irregular surface changes. Comply with compaction requirements and grade to cross sections, lines, and elevations indicated.
1. Provide a smooth transition between adjacent existing grades and new grades.
 2. Cut out soft spots, fill low spots, and trim high spots to comply with required surface tolerances.
- B. Site Grading

1. Slope grades to direct water away from buildings and to prevent ponding. Finish subgrades to required elevations within the following tolerances:
 - a. Lawn or unpaved areas shall be graded to plus or minus (1 inch).
 - b. Walks shall be graded to plus or minus (1 inch).

C. Grading inside Building Lines

1. Finish subgrade to a tolerance of 1/2-inch when tested with a 10-foot straightedge.

END OF SECTION 310000

SECTION 311000 - DEWATERING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes construction dewatering.
- B. Related Sections include the following:
 - 1. Division 31 - Section 310000 Earthwork.

1.3 PERFORMANCE REQUIREMENTS

- A. Dewatering Performance: Design, furnish, install, test, operate, monitor, and maintain dewatering system of sufficient scope, size, and capacity to control ground-water flow into excavations and permit construction to proceed on dry, stable subgrades.
 - 1. Maintain dewatering operations to ensure erosion control, stability of excavations and constructed slopes, that excavation does not flood, and that damage to subgrades and permanent structures is prevented.
 - 2. Prevent surface water from entering excavations by grading, dikes, or other means.
 - 3. Accomplish dewatering without damaging existing buildings adjacent to excavation.
 - 4. Remove dewatering system if no longer needed.

1.4 SUBMITTALS

- A. Shop Drawings for Information: For dewatering system. Show arrangement, locations, and details of wells and well points; locations of headers and discharge lines; and means of discharge and disposal of water.
 - 1. Include layouts of piezometers and flow-measuring devices for monitoring performance of dewatering system.
 - 2. Include a written report outlining control procedures to be adopted if dewatering problems arise.
 - 3. Include Shop Drawings signed and sealed by the qualified professional engineer responsible for their preparation.
- B. Qualification Data: For Installer and Professional Engineer.

- C. Photographs or videotape, sufficiently detailed, of existing conditions of adjoining construction and site improvements that might be misconstrued as damage caused by dewatering operations.
- D. Record drawings at Project closeout identifying and locating capped utilities and other subsurface structural, electrical, or mechanical conditions performed during dewatering.
 - 1. Note locations and capping depth of wells and well points.
- E. Field Test Reports: Before starting excavation, submit test results and computations demonstrating that dewatering system is capable of meeting performance requirements.

1.5 QUALITY ASSURANCE

- A. Regulatory Requirements: Comply with water disposal requirements of authorities having jurisdiction.

1.6 PROJECT CONDITIONS

- A. Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted in writing by the Engineer and then only after arranging to provide temporary utility services according to requirements indicated.
- B. Project-Site Information: A geotechnical report has been prepared for this Project and is available for information only. The opinions expressed in this report are those of geotechnical engineer and represent interpretations of subsoil conditions, tests, and results of analyses conducted by geotechnical engineer. Owner will not be responsible for interpretations or conclusions drawn from this data.
 - 1. Make additional test borings and conduct other exploratory operations necessary for dewatering.
 - 2. The geotechnical report is referenced elsewhere in the Project Manual.
- C. Survey adjacent structures and improvements, employing a qualified professional engineer or land surveyor, establishing exact elevations at fixed points to act as benchmarks. Clearly identify benchmarks and record existing elevations.
 - 1. During dewatering, regularly resurvey benchmarks, maintaining an accurate log of surveyed elevations for comparison with original elevations. Promptly notify the Engineer if changes in elevations occur or if cracks, sags, or other damage is evident in adjacent construction.

PART 2 - PRODUCTS - NOT USED

PART 3 - EXECUTION

3.1 PREPARATION

- A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by dewatering operations.
 - 1. Prevent surface water and subsurface or ground water from entering excavations, from ponding on prepared subgrades, and from flooding site and surrounding area.
 - 2. Protect subgrades and foundation soils from softening and damage by rain or water accumulation.
- B. Install dewatering system to ensure minimum interference with roads, streets, walks, and other adjacent occupied and used facilities.
 - 1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction. Provide alternate routes around closed or obstructed traffic ways if required by authorities having jurisdiction.

3.2 INSTALLATION

- A. Install dewatering system utilizing wells, well points, or similar methods complete with pump equipment, standby power and pumps, filter material gradation, valves, appurtenances, water disposal, and surface-water controls.
- B. Before excavating below ground-water level, place system into operation to lower water to specified levels. Operate system continuously until drains, sewers, and structures have been constructed and fill materials have been placed, or until dewatering is no longer required.
- C. Provide an adequate system to lower and control ground water to permit excavation, construction of structures, and placement of fill materials on dry subgrades. Install sufficient dewatering equipment to drain water-bearing strata above and below bottom of foundations, drains, sewers, and other excavations.
 - 1. Do not permit open-sump pumping that leads to loss of fines, soil piping, subgrade softening, and slope instability.
- D. Reduce hydrostatic head in water-bearing strata below subgrade elevations of foundations, drains, sewers, and other excavations.
 - 1. Maintain piezometric water level a minimum of 24 inches below surface of excavation.
- E. Dispose of water removed by dewatering in a manner that avoids endangering public health, property, and portions of work under construction or completed. Dispose of water in a manner that avoids inconvenience to others. Provide sumps, sedimentation tanks, and other flow-control devices as required by authorities having jurisdiction.
- F. Provide standby equipment on-site, installed and available for immediate operation, to maintain dewatering on continuous basis if any part of system becomes inadequate or fails. If dewatering requirements are not satisfied due to inadequacy or failure of

dewatering system, restore damaged structures and foundation soils at no additional expense to Owner.

1. Remove dewatering system from Project site on completion of dewatering. Plug or fill well holes with sand or cut off and cap wells a minimum of 36 inches (900 mm) below overlying construction.

- G. Damages: Promptly repair damages to adjacent facilities caused by dewatering operations.

3.3 OBSERVATION WELLS

- A. Provide, take measurements, and maintain at least the minimum number of observation wells or piezometers indicated and additional observation wells as may be required by authorities having jurisdiction.
- B. Observe and record daily elevation of ground water and piezometric water levels in observation wells.
- C. Repair or replace, within 24 hours, observation wells that become inactive, damaged, or destroyed. Suspend construction activities in areas where observation wells are not functioning properly until reliable observations can be made. Add or remove water from observation-well risers to demonstrate that observation wells are functioning properly.
 1. Fill observation wells, remove piezometers, and fill holes when dewatering is completed.

END OF SECTION 311000

SECTION 312100 - EXCAVATION SUPPORT AND PROTECTION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes temporary excavation support and protection systems.
- B. Related Sections include the following:

- 1. Section 310000

1.3 PERFORMANCE REQUIREMENTS

- A. Design, furnish, install, monitor, and maintain excavation support and protection system capable of supporting excavation sidewalls and of resisting soil and hydrostatic pressure and superimposed and construction loads.
 - 1. Provide professional engineering services needed to assume engineering responsibility, including preparation of Shop Drawings and a comprehensive engineering analysis by a qualified professional engineer.
 - 2. Prevent surface water from entering excavations by grading, dikes, or other means.
 - 3. Install excavation support and protection systems without damaging existing buildings, pavements, and other improvements adjacent to excavation.
 - 4. If steel sheet piling is utilized, consider vibrating it to required depth to minimize ground vibrations.

1.4 SUBMITTALS

- A. Shop Drawings for Information: Prepared by or under the supervision of a qualified professional engineer for excavation support and protection systems.
 - 1. Include Shop Drawings signed and sealed by the qualified professional engineer responsible for their preparation, registered with the State of Ohio.
- B. Qualification Data: For Installer and professional engineer.
- C. Photographs or videotape, sufficiently detailed, of existing conditions of adjoining construction and site improvements that might be misconstrued as damage caused by the absence of, the installation of, or the performance of excavation support and protection systems.

1.5 PROJECT CONDITIONS

- A. Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted in writing by the Owner and then only after arranging to provide temporary utility services according to requirements indicated.
- B. Project-Site Information: A geotechnical report has been prepared for this Project and is available for information only. The opinions expressed in this report are those of geotechnical engineer and represent interpretations of subsoil conditions, tests, and results of analyses conducted by geotechnical engineer. Owner will not be responsible for interpretations or conclusions drawn from this data.
 - 1. Make additional test borings and conduct other exploratory operations necessary for excavation support and protection.
 - 2. The geotechnical report is referenced elsewhere in the Project Manual.
- C. Survey adjacent structures and improvements, employing a qualified professional engineer or land surveyor; establish exact elevations at fixed points to act as benchmarks. Clearly identify benchmarks and record existing elevations.
 - 1. During installation of excavation support and protection systems, regularly resurvey benchmarks, maintaining an accurate log of surveyed elevations and positions for comparison with original elevations and positions. Promptly notify Engineer if changes in elevations or positions occur or if cracks, sags, or other damage is evident in adjacent construction.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. General: Provide materials that are either new or in serviceable condition.
- B. Structural Steel: ASTM A 36, or ASTM A 992.
- C. Steel Sheet Piling: ASTM A 328, ASTM A 572, or ASTM A 690 with continuous interlocks.
- D. Wood Lagging: Lumber, mixed hardwood, nominal rough thickness of 3 inches or greater.
- E. Cast-in-Place Concrete: ACI 301, of compressive strength required for application.
- F. Reinforcing Bars: ASTM A 615, Grade 60.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by ground vibration, settlement, lateral movement, undermining, washout, and

other hazards that could develop during excavation support and protection system operations.

1. Shore, support, and protect utilities encountered.
- B. Install excavation support and protection systems to ensure minimum interference with roads, streets, walks, and other adjacent occupied and used facilities.
 1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction. Provide alternate routes around closed or obstructed traffic ways if required by Owner.
- C. Locate excavation support and protection systems clear of permanent construction so that forming and finishing of concrete surfaces is not impeded.
- D. A competent person (OSHA Definition) must monitor excavation support and protection systems daily during excavation progress and for as long as excavation remains open. Promptly correct bulges, breakage, or other evidence of movement to ensure that excavation support and protection systems remain stable.
- E. Promptly repair damages to adjacent facilities caused by installing excavation support and protection systems.

3.2 SOLDIER BEAMS AND LAGGING

- A. Install steel soldier beams before starting excavation. Space soldier beams at regular intervals not to exceed allowable flexural strength of wood lagging. Accurately align exposed faces of flanges to vary not more than 2 inches (50 mm) from a horizontal line and not more than 1:120 out of vertical alignment.
- B. Install wood lagging within flanges of soldier beams as excavation proceeds. Trim excavation as required to install lagging. Fill voids behind lagging with soil, and compact.
- C. Install wales horizontally at centers indicated and secure to soldier beams.

3.3 SHEET PILING

- A. Before starting excavation, install one-piece sheet piling lengths and tightly interlock to form a continuous barrier. Limit vertical offset of adjacent sheet piling to 60 inches (1500 mm). Accurately align exposed faces of sheet piling to vary not more than 2 inches (50 mm) from a horizontal line and not more than 1:120 out of vertical alignment. Cut tops of sheet piling to uniform elevation at top of excavation.

3.4 TIEBACKS

- A. Tiebacks: Drill for, install, grout, and tension tiebacks into position. Test load-carrying capacity of each tieback and replace and retest deficient tiebacks.

1. Test loading shall be observed by a qualified professional engineer responsible for design of excavation support and protection system.
2. Maintain tiebacks in place until permanent construction is able to withstand lateral earth and hydrostatic pressures.

3.5 BRACING

- A. Bracing: Locate bracing to clear columns, floor framing construction, and other permanent work. If necessary to move brace, install new bracing before removing original brace.
 1. Do not place bracing where it will be cast into or included in permanent concrete work, unless otherwise approved by the Engineer.
 2. Install internal bracing, if required, to prevent spreading or distortion of braced frames.
 3. Maintain bracing until structural elements are supported by other bracing or until permanent construction is able to withstand lateral earth and hydrostatic pressures.

3.6 REMOVAL AND REPAIRS

- A. Remove excavation support and protection systems when construction has progressed sufficiently to support excavation and bear soil and hydrostatic pressures. Remove in stages to avoid disturbing underlying soils or damaging structures, pavements, facilities, and utilities.
 1. Repair or replace, as approved by the Engineer, adjacent work damaged or displaced by removing excavation support and protection systems.

END OF SECTION 312100

SECTION 312316.13 - TRENCH EXCAVATING, BEDDING AND BACKFILL

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Work Included: All trench excavations and fills to the lines and grades given for conduits, pipelines, etc. as required for proper completion of the work of this contract as shown on the Contract Drawings.
- B. The trench excavation work item in this contract shall include the removal, handling, rehandling, filling, and disposal of any and all materials (whether they be wet or dry) found unsuitable by the Engineer encountered within the limits of the work and the transportation and placing thereof, and shall include all pumping, bailing, draining, sheeting and shoring, backfill, refill and protection, and sand backfill, together with rolling and tamping where such is required by these specifications and is not specifically included in another item of work in this contract.
- C. Existing ground elevations of the work site(s) are shown by figures and/or by contours on the Contract Drawings. The contours and elevations of the present ground are believed to be reasonably correct, but do not purport to be absolutely so, and are presented only as an approximation. The Contractor shall satisfy himself, however, by his own actual examination of the site of the work, as to both the existing elevations and the amount of work required under this Section. If the Contractor is not willing to accept the ground surface elevations indicated upon the Drawings for payment, he shall notify the Engineer prior to the starting of any excavation work.

1.2 QUALITY ASSURANCE

- A. State and local code requirements shall control the construction specified herein.
 - 1. Ohio Department of Transportation (latest edition) for the products specified herein.
- B. Compaction testing shall be performed by a soil testing laboratory as specified in Section 013319. Testing shall be in accordance with ASTM Standards:
 - 1. C33 Specification for Concrete Aggregates.
 - 2. D698 Tests for Moisture – Design of Relations of Soils.
 - 3. D1556 Test for Density of Soil-in-Place by the Sand Cone Method.
 - 4. D2922 Test for Density of Soil and Soil Aggregates in Place by Nuclear Methods.

1.3 SUBMITTALS

- A. Certifications attesting that the composition analysis of pipe protection and material stone backfill materials meet specification requirements.
- B. Reference Submittals:

1. Material Certification: Provide material certification for the items below:
2. Granular backfill material.
3. Pipe bedding material.
4. Test Reports: Provide two copies of test reports.

1.4 JOB CONDITIONS

A. Control of Traffic

1. The Contractor shall provide all traffic control measures in accordance with the Ohio Department of Transportation as prescribed by the Ohio Manual of Uniform Traffic Control Devices.

B. Utility Services

1. The Contractor shall be responsible for maintaining all building utility service connections during the excavation and backfill process.
2. Immediately report to the utility company and the Engineer any break, leak or other damage to the lines or protective coatings made or discovered.
3. Allow free access to utility company personnel at all times for purposes of maintenance, repair and inspection.

PART 2 - PRODUCTS

2.1 PIPE BEDDING MATERIAL

- A. Granular material shall be crushed stone size as shown on Table 703-01 (ODOTCMS), No. 57, 6, 67, 68, or 7.

2.2 BACKFILL MATERIAL

- A. Backfill materials shall be either natural materials or granular materials as specified below.
 1. Type A. Granular material as specified in ODOT Item 304.
 2. Type B. Natural soil free from stones larger than 2 inches across their greatest dimension, top soil, vegetation, debris, rubbish or frozen material. When approved by the Contract Administrator, stones no larger than 8" across their greatest dimension may be deposited at least 2 feet above the top of the pipe.
 3. Type C. Low Strength Mortar as specified in ODOT Item 613.
- B. The backfill under and/or within five feet of existing or proposed roadways, paved shoulders, curbs, existing parking areas and drives shall be Type A granular material.

2.3 UTILITY MARKING TAPE

- A. Three (3) inch wide detectable utility marking tape bearing wording based upon the utility involved permanently printed on the tape. Tape color shall comply with the APWA color code.

2.4 TRACER WIRE

- A. Metallic detectable underground wire shall be located as shown on standard details. Tracer wire shall be 12 AWG Solid Copper Wire designed specifically for detecting underground utilities and direct burial use.
- B. At all valves, line beginnings and ends, the wire shall be clamped to a 3-foot-long piece of ½-inch rebar with a brass clamp. The rebar shall be placed vertically next to the valve or structure and extend 2 inches above finished grade.
- C. Tracer Wire shall be installed on top of pipe bedding or 12 inches above pipe crown on all force mains and non-metallic pipe.

PART 3 - EXECUTION

3.1 GENERAL PREPARATION

- A. Trench Excavation shall follow lines and grades as indicated on the plans. Exact positions shall be subject to and adjusted to interferences with related work and real-world conditions.
- B. Leave Trenches open until inspected by Engineer.
- C. Prior to beginning excavation, notify the Ohio Utilities Protection Service as required and notify all utilities on the project of the intended work schedule.
- D. Locate all existing utilities or other structure of critical location in advance of excavation.
- E. Uncover existing pipes and cables ahead of trenching for new work.
- F. Whenever existing items such as sewer pipes, water pipes, gas mains, culverts, or other pipes or structures are encountered in or near the lines of trenches being excavated, use proper care in preserving operation of such items intact and immediately repair any damage to such items.

3.2 MAINTENANCE AND PROTECTION OF TRAFFIC

- A. Coordinate the work to insure the least inconvenience to traffic and maintain traffic in one or more unobstructed lanes unless closing the street is authorized.
- B. Maintain access to all streets and private drives.

- C. Provide and maintain signs, flashing warning lights, barricades, markers, and other protective devices as required to conform with construction operations and to keep traffic flowing with minimum restrictions.
- D. Comply with state and local codes, permits and regulations.

3.3 CUTTING PAVED SURFACES

- A. Where installation of pipelines, miscellaneous structures, and appurtenances necessitate breaking a paved surface, make cuts in a neat uniform fashion forming straight lines parallel with the centerline of the trench.
- B. Protect edges of cut pavement during excavation to prevent raveling or breaking; square edges prior to pavement replacement.
- C. The requirement for neat line cuts, in other than state highways, may be waived if the final paving restoration indicates overlay beyond the trench width.

3.4 BLASTING

- A. Blasting will not be permitted.

3.5 METHOD OF TRENCH EXCAVATION

- A. All excavation shall be in open cut, unless otherwise permitted by the Engineer.
- B. Excavation shall be made to undisturbed finish subgrade six (6) inches below the bottom of the pipe or structure, unless otherwise shown on the Drawings.
- C. Where unsuitable bearing material is encountered the trench shall be excavated to an additional depth below the excavation for the bottom of the pipe barrel of six (6) inches for pipe of twenty-four (24) inches diameter and smaller and of nine (9) inches for pipe greater than twenty-four (24) inches in diameter. This additional excavation is to be refilled with suitable material in a satisfactory manner to provide the proper foundation for the conduit bed.
- D. Trench must be excavated with vertical sides from the bottom of the trench to one (1) foot above the top of the pipe, from which point sides may slope to ground surface, except that, in streets or roadways, trenches must be excavated with vertical sides to the top of the trench. Width of trench in the vertical section shall be excavated only as wide as necessary to provide free forking space on each side of the piping according to the size of the pipe and the character of the ground. In every case there shall be sufficient space between the pipe and the sides of the trench to make it possible to thoroughly compact the backfill around the pipe and to secure tight joints, but in no case more than one (1) foot on either side of pipe. In no case, however, shall the width of the trench at the top of the pipe exceed the dimensions as shown on the Contract Drawings. In no case will it be permitted to excavate pipe trenches with sides sloping to the bottom.
- E. Bottom of trench bed must give a full, firm but slightly yielding support to the lower section of the pipe and so that the pipe barrel is firmly supported in the cradle throughout

its entire length, in such manner as to prevent any subsequent settlement of the pipe. Boulders or loose rocks which might bear against the pipe will not be permitted in the trench bottom or sides below two (2) feet above the pipe. Bell holes must be excavated to assure full length bearing of the pipe barrel.

- F. Trenches must be kept free from water until the material in the joints has sufficiently set.
- G. At no time shall the Contractor advance trenching operations more than 400 feet ahead of completed pipeline, including backfill, except as approved by the Engineer.
- H. Where the Contractor, by error or intent, excavates beyond the minimum required depth, the trench shall be brought to the required pipeline grade with bedding material.

3.6 SUPPORT OF EXCAVATION

- A. The Contractor shall be responsible for supporting and maintaining all excavations required hereunder utilizing a trench box and even to the extent of sheeting, shoring the sides and ends of excavations with timber or other satisfactory supports. If the sheeting, braces, shores, and stringers or walling timbers or other supports are not properly placed or are insufficient, the Contractor shall provide additional or stronger supports. The requirements of sheeting or shoring, or of the addition of supports, shall not relieve the Contractor of this responsibility for their sufficiency. All trench protection and sheeting and shoring must conform to the regulations of the Federal Occupations Safety and Health (OSHA) and will be subject to conform to their respective inspections. All orders of the OSHA representatives must be complied with by the Contractor.
- B. All timbering shall be removed where and when required and, upon its removal, all voids carefully and compactly filled. If any timber is ordered in writing to be left in place, it shall be cut-off as directed and will be paid for with a Change Order. No payment will be made for wasted ends or for timber left in place without specific written authorization by the Engineer.

3.7 REMOVAL OF WATER

- A. The Contractor shall pump out or otherwise remove and dispose of, as fast as it may collect any water, sewage, or any other liquids which may be found or may accumulate in the excavation, regardless of whether it be water or liquid wastes from his own contract or from existing conduits and works.
- B. Maintain pipe trenches dry until pipe has been jointed, inspected, and backfilled, and concrete work has been completed. Preclude trench water from entering pipelines under construction.
- C. Intercept and divert surface drainage away from excavations. Design surface drainage systems so that they do not cause erosion on or off the site, or cause unwanted flow of water.
- D. There shall be, upon the work at all times during the construction, proper and approved pumps and machinery of sufficient capacity to meet the maximum requirements for the removal of water or other liquids and their disposal.

- E. Dewatering operations shall in no way violated the conditions of the storm water pollution prevention plan (SWPPP), or the EPA regulations for Construction Storm Water.

3.8 BEDDING

- A. Bedding material below the pipe and that under and around the pipe to spring line shall be well tamped. That above spring line shall be placed in six (6) inch layers and be well tamped to a minimum height of twelve (12) inches above the top of the pipe.
- B. Where foundation conditions are such that the above types of bedding cannot be provided, as in quicksand, etc., special provisions shall be made as called for by the Drawings or as directed by the Engineer by providing concrete cradle or lumber foundations.

3.9 UNAUTHORIZED EXCAVATIONS

- A. All excavations carried outside of the lines and grades given or specified, together with the disposal of such material, and all excavations and other work resulting from slides, cave-ins, swellings or upheavals shall be at the Contractor's own cost and expense. All spaces resulting from unauthorized excavations or from slides or cave-ins shall be refilled at the Contractor's expense with concrete or other suitable material.

3.10 ADDITIONAL EXCAVATION

- A. It is expected that satisfactory foundations will be found at the elevations shown on the Drawings, but in case the material encountered is not suitable, or in case it is found desirable or necessary to go to additional depth, the excavation shall be carried to an additional depth as ordered and refilled as directed by the Engineer.

3.11 THRUST RESTRAINT

- A. Provide pressure and vacuum pipe with concrete thrust blocking at all bends, tees, valves, and changes in direction, in accordance with the Contract Drawings.

3.12 BACKFILLING

- A. As the various pipelines, conduits, etc. or parts of same are completed and inspected, the Contractor shall refill the space under, around and over with material as specified herein. Unless otherwise directed, all forms, bracing and lumber shall be removed during backfilling and the cavities and voids resulting from the removal shall be thoroughly backfilled.
- B. The bedding material shall be as specified and placed in accordance with the standard details. The limits of bedding shall be as indicated on the Standard Details for the respective pipes. The Contractor must use special care in placing this portion of the backfill so as to avoid injuring or moving the pipe when compacting the backfill. When the backfill has progressed to the limits shown on the Standard Details for the respective pipe, the work of backfilling shall be stopped, and the backfill in place shall be tamped or puddled as directed. Care shall be taken to prevent floating of the pipe.

- C. No cinders, rubbish, rocks, boulders, shale or other objectionable material shall be used as backfill against the pipe or in any part of the trench when, in the opinion of the Engineer, it will be injurious to the work. No backfilling shall be done with frozen materials upon frozen materials.
- D. Over sewers and other arched structures built in place and after the structure is completed and before the supports or centers are struck, the trenches shall be carefully filled by depositing without shock and by tamping suitable earth or other selected material at the sides and to a height not less than two (2) feet above the top of the pipe. This backfill shall be graded evenly across the trench. This backfilling must be done as the work progresses, and before any filling is deposited directly from a machine, bucket, cars, wagon, or other vehicles. The backfilling shall then be brought up evenly and all eccentric loading shall be avoided. In no case shall material dumped from bucket, truck or bulldozer be allowed to fall directly upon any conduit, pipe or other structure, and, in all cases, the bucket must be lowered so that the shock of the falling material will not injure the structure.
- E. The backfill shall be placed and compacted, using power driven mechanical tampers in layers of six (6) inch compacted thickness unless approved by the Engineer. Final paving shall be as shown on the Contract Drawings and Standard Details.

3.13 DISPOSAL OF WASTE

- A. A selected portion of the excavate material will be used for backfilling or filling about the pipe as ordered. Excavated material in excess of that needed for backfilling and filling and unsuitable material shall be disposed of by the Contractor at his own expense, and the cost of such disposal shall be deemed as having been included in the unit or lump sum prices bid.
- B. Prior to disposal, the Contractor shall obtain and submit to the Engineer written permission from the owner of the property upon which the material and debris are to be placed.

3.14 COMPACTION REQUIREMENTS

- A. Control soil compaction during construction to provide the minimum percentage of density specified for each area as determined according to ASTM D698.
- B. Provide not less than the following maximum density of soil material compacted at optimum moisture content for the actual density of each layer of soil material in place, and as approved by the Engineer:
 - 1. Structures, Pavements, Walkways, Curbs and Steps:
 - a. Compact the subgrade and each layer of fill material or backfill material at 98% of maximum density.
 - 2. Lawn and Unpaved Area:
 - a. Compact each layer of fill material or backfill material at 90% of maximum density.

C. Moisture Control:

1. Where subgrade or layer of soil material must be moisture conditioned before compacting, uniformly apply water to surface of subgrade or layer of soil material to prevent free water appearing on surface during or subsequent to compacting operations.
 - a. Remove and replace, or scarify and air dry, soil material that is too wet to permit compacting to specified density.
 - b. Soil material that has been removed because it is too wet to permit compacting may be stockpiled or spread and allowed to dry. Assist drying by disking, harrowing, or pulverizing until moisture content is reduced to a satisfactory value as determined by moisture-density relation tests approved by the test laboratory.

D. Unsuitable Backfill Material:

1. Where the Engineer deems backfill material to be unsuitable and rejects all or part thereof due to conditions prevailing at the time of construction, remove the unsuitable material and replace with select material stone backfill or suitable foreign backfill material.
2. Compaction testing shall be required every 100 cubic yards or as required by the Engineer. Backfill found to be deficient shall be removed and re-compacted until compliant at no additional cost to the Owner.

3.15 UTILITY MARKING TAPE

- A. Install detectable utility marking tape above all plastic pipelines, eighteen (18) to twenty-four (24) inches below final grade.

3.16 ROUGH GRADING

- A. Rough grade areas disturbed by construction to a uniform finish. Form the bases for terraces, banks, lawns and paved areas.
- B. Grade areas to be paved to depths required for placing sub-base and paving materials.
- C. Rough grade areas to be seeded three (3) inches below indicated finish contours.

3.17 RESTORATION OF UNPAVED SURFACES

- A. Restore unpaved surfaces disturbed by construction to equal the surface condition prior to construction.
- B. Restore grassed areas in accordance with Section 329200.19, Seeding and Mulching.

3.18 MAINTENANCE

- A. Protection of newly graded areas:

1. Protect newly graded areas from traffic and erosion, and keep free from trash and weeds.
 2. Repair and reestablish grades in settled, eroded, and rutted areas to the specified tolerances.
- B. Where completed compacted areas are disturbed by subsequent construction operations or adverse weather, scarify the surface, reshape, and compact to the required density prior to further construction.

END OF SECTION 312316.13

SECTION 312323.14 – COMPACTED GRANULAR BACKFILL

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

1.2 DESCRIPTION OF WORK

- A. The Contractor shall furnish, place and compact all the materials needed.

PART 2 - PRODUCTS

2.1 MATERIAL

- A. Aggregate shall be ODOT 304 crushed limestone. Crushed gravel or slag products are unacceptable.
- B. Contractor shall submit current test reports for the lot(s) of the material to be supplied.

PART 3 - EXECUTION

3.1 PLACING AND COMPACTING

- A. Compacted granular backfill shall be properly placed in layers sufficient to meet the compaction requirement of 100% of maximum laboratory dry density per ASTM D 698 throughout the entire layer and thoroughly compacted with mechanical compaction equipment with moisture adjustment as needed. Should after settlement occur, the Contractor must add and compact additional material, and he must maintain the backfill at the required finished grade or sub-grade until the project is satisfactorily completed and during the correction period.
- B. Approved mechanical compaction equipment shall be used for tamping backfill. Flooding, jetting or puddling of backfill will not be permitted.

END OF SECTION 312323.14

SECTION 312323.33 - LOW STRENGTH MORTAR BACKFILL MATERIAL

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of contract, including General and Supplementary Conditions and Division - 1 Specification sections, apply to work of this section.

1.2 DESCRIPTION OF WORK

- A. This work shall consist of the placement of a flowable low strength mortar for backfilling conduits or at other locations as shown on the plans or as specified. The work shall be in accordance with ODOT Item 603 and 499 unless otherwise specified.

1.3 QUALITY ASSURANCE

- A. In addition to requirements of these specifications, comply with manufacturer's instructions and recommendations for work.

1.4 SUBMITTALS

- A. Product Data: Submit manufacturer's technical data and application instructions.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Cement

- 1. ODOT 701.01 or ODOT 701.04.

B. Fly Ash

- 1. Fly Ash shall come from a source approved by the Engineer.

C. Fine Aggregate

- 1. Fine Aggregate shall be natural sand consisting of mineral aggregate particles. The gradation of the sand shall be as follows:

<u>Sieve Size</u>	<u>Percent Passing</u>
3/4"	100
200	0 - 10

- 2. It is intended that the sand be fine enough to stay in suspension in the mixture to the extent required for proper flow. The Engineer reserves the right to reject the sand if a flowable mixture cannot be produced.

2.2 MORTAR MIX PROPORTIONING

- A. The initial trial mixture shall be as follows:

Quantity of Dry Materials per Cubic Yard

Cement	100 lbs.
Fly Ash	250 lbs.
Sand (SSD)*	2700 lbs.
Water	500 lbs.
* saturated-surface dry	

- B. These quantities of materials are expected to yield approximately 1 cubic yard of mortar of the proper consistency. Adjustments of the proportions may be made providing the total absolute volume of the materials is maintained.

PART 3 - EXECUTION

3.1 TRIAL BATCH

- A. To expedite consolidation of the mortar, it will be necessary for bleed water to appear on the surface immediately after the mortar is struck off.

A delay in bleeding indicates there are too many fines in the mixture, so the fly ash quantity shall be reduced in increments of 50 lbs. until mixture is bleeding freely. Approximately 60 lbs. of sand shall be added to replace each 50 lbs. of fly ash to maintain the original yield.

- B. Fluidity of the mortar mixture shall be measured by the Corps. of Engineers' Flow Cone Method according to CRD-C611. Prior to filling the flow cone with mortar, the mixture shall be passed through a 1/4-inch screen. Time of efflux shall be approximately 12 seconds.
- C. Prior to the first placement, the Contractor shall make one or more trial batches of mortar of the size to be hauled to job site and shall cast one or more test samples equivalent to the approximate dimensions of the trench to be backfilled (either in a form or trench). Amount of bleeding, settlement rate and time required to support pavement replacement shall be determined from these full-size tests. The Contractor shall furnish the required materials and samples.

3.2 MIXING EQUIPMENT

- A. Sufficient mixing capacity of mixers shall be provided to permit the mortar to be placed without interruption.

3.3 PLACING MORTAR

- A. Flowable mortar shall be discharged from the mixer by any reasonable means into the space to be filled. The fill material shall be brought up uniformly to the fill line shown on the plans or as directed by the Engineer.

END OF SECTION 312323.33

SECTION 312333 - UNDERGROUND CONDUIT INSTALLATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. The Construction Drawings and General Provisions of this Contract including the General and Supplementary Conditions, Specific Project Requirements, Proposal, and all referenced standard specifications apply to work defined in this section.

1.2 DESCRIPTION

- A. This work shall consist of the construction or reconstruction of underground pipe conduits in accordance with these specifications and in reasonable close conformance to the lines and grades shown on the detailed plans or as otherwise established by the Engineer.
- B. This work shall include excavating for the conduit, fittings, and appurtenances; clearing and grubbing and removal of all materials necessary for placement of the conduit except any items paid for separately; furnishing and placing bedding and backfill as required; constructing and subsequently removing all necessary cofferdams, cribs and sheeting; pumping and dewatering; making all conduit joints as required; installing all necessary conduit; joining to existing and proposed appurtenances as required; performing leakage tests as required; restoration of all disturbed facilities and surfaces. The work shall also include the maintenance of existing flow and service to facilities being modified. Procedures for such maintenance shall be as approved by the Engineer prior to any work commencing.

PART 2 - MATERIALS

2.1 CONDUIT

- A. All conduit utilized shall be of one type and size specified in the proposal meeting the requirements of the detailed material specification.
- B. Shop drawings, catalog cuts, and test certifications may be required by the Engineer for all conduit, fittings, and appurtenances.
- C. Aggregate for the bedding and backfill shall conform to the requirements of the plan detail or as modified in writing by the Engineer. All aggregates shall conform to ODOT 703 for soundness and gradation.
- D. All other materials utilized as part of this work shall meet their respective ASTM requirements.

PART 3 - EXECUTION

3.1 REMOVAL OF STRUCTURES AND OBSTRUCTIONS

A. Pavement, Sidewalks, and Curbing

1. Removal of existing pavements, sidewalks, curbing, and similar structures shall end at an existing joint or a sawed joint. Sawed joints shall be straight, neat, and free from chipped or damaged edges.
2. For non-reinforced concrete, the saw cut shall be completely through concrete.
3. For reinforced concrete, the saw cut shall be completely through the steel and concrete.
4. If the concrete is coated with a bituminous surface or other material, the saw cut shall be as specified above.

B. Manholes, Catch Basins, and Inlets

1. Existing drainage structures and sanitary manholes designated by the Engineer to be removed shall be completely removed.
2. Manholes designated to be abandoned shall be removed to an elevation of at least 3 ft. below the finished subgrade or ground surface. The remaining void shall be filled with backfill material in accordance with Section 312323.13 - Compacted Backfill.
3. Live sewers connected to structures removed or abandoned shall be rebuilt through the area with new conduit. Sewer flow shall be maintained between removal and replacement operations. Abandoned sewers shall be sealed and made watertight with approved precast stoppers or masonry bulkheads.
4. All castings salvaged from abandoned or removed structures shall remain the property of the Owner and shall be cleaned and transported by the Contractor to a nearby site designated by the Owner or incorporated in the work where called for on the drawings.

C. Guardrail and Fence

1. Where necessary, existing guardrail and fence shall be carefully dismantled and stored for reuse or for salvage by the Owner.
2. Posts and other materials not considered salvageable by the Engineer shall be disposed of by the Contractor.
3. The Contractor will be required to replace, at no cost to the Owner, material lost or damaged by negligence or by the use of improper methods.

3.2 METHOD OF EXCAVATION

- A. All excavation shall be in open cut unless otherwise permitted by the Engineer. Loosening of material by blasting will not be permitted without written authorization by the Owner specifying both the extent and location of the blasting to be done. If permission is granted the Contractor shall submit in writing his means and methods of blasting to the Owner for approval. Blasting shall not begin until the Owner issues written approval of the means and method of blasting.

- B. Excavation shall be made to undisturbed finish subgrade to the depth below the bottom of the conduit or structure as shown on the Contract Drawings details.
- C. Trenches shall be excavated with vertical sides from the bottom of the trench to one (1') foot above the top of the conduit from which point sides may slope to ground surface, except that, in streets or roadways, trenches shall be excavated with near vertical sides to the top of the trench. Width of trench in the vertical section shall be excavated only as wide as necessary to accommodate a safety box and to provide free working space on each side of the conduit or structure according to the size of the conduit or structure and the character of the ground. In every case there shall be sufficient space between the conduit or structure and the sides of the trench to make it possible to thoroughly ram the bedding around the conduit or structure and to secure tight conduit joints, but in no case more than twelve inches on either side of conduit. In no case, however, shall the width of the trench at the top of the conduit exceed the dimensions as shown on the contract drawings. In no case will it be permitted to excavate conduit trenches with sides sloping to the bottom.
- D. The trench bottom shall be firm and uniform for its full length. Should unstable material be encountered below plan subgrade, it shall be removed to a depth directed by the Engineer. Replacement of the additional excavation shall be with the specified bedding material or as otherwise directed by the Engineer.
- E. In the case the flow line is changed not to exceed one (1) foot or it becomes necessary to remove unstable material in an amount not to exceed one (1) foot, the same shall be done at one contract bid price or amount. When the flow line is lowered more than (1 foot) or if it becomes necessary to remove more than (1 foot) of unsuitable material below the bottom of the trench, compensation will be provided therefore in a supplemental agreement for the excavation and backfill beyond (1 foot).

3.3 UNAUTHORIZED EXCAVATIONS

- A. All excavations carried outside of the lines and grades given or specified, together with the disposal of such material, and all excavations and other work resulting from slides, cave-ins, swellings or upheavals shall be at the Contractor's own cost and expense. All spaces resulting from unauthorized excavations or from slides or cave-ins shall be refilled at the Contractor's expense with suitable material as specified in ODOT Item 203, "Roadway Excavation and Embankment" or Section 312323.13, "Compacted Backfill" in designated areas shown on the contract drawings or specified under this Section. Compaction requirements shall be in accordance with these specifications.

3.4 SHEETING AND SHORING

- A. The Contractor shall be responsible for supporting and maintaining all excavations required even to the extent of sheeting or shoring the sides and ends of excavations with timber or other satisfactory supports. If the sheeting, braces, shores, stringers, waling timbers, or other supports are not properly placed or are insufficient, the Contractor shall provide additional or stronger supports. The requirements of sheeting or shoring or of the addition of supports shall not relieve the Contractor of his responsibility for their

sufficiency. All trench protection and sheeting and shoring must conform to the regulations of both the Ohio State Industrial Commission (OSIC) and the Federal Occupational Safety and Health Act (OSHA) and will be subject to their respective inspections. All orders of OSIC and OSHA representatives must be complied with by the Contractor.

- B. All sheeting and shoring shall be removed where and when required and, upon its removal, all voids filled. If any sheeting or shoring is ordered to be left in place, it shall be cut-off as directed. In compensation for the sheeting and shoring left in place, if any, shall be by prior written change order.

3.5 REMOVAL OF WATER

- A. All conduit shall be installed in a dry and stable trench. The Contractor may pump or otherwise remove any water, sewage, or other liquid that may be found or may accumulate in the trench.
- B. If, in the opinion of the Contractor, dewatering pumps and equipment are required to maintain a dry and stable trench, suitably sized pumps shall be provided to meet the requirements. The manner and spacing of well points shall be at the Contractor's discretion.
- C. Excess water shall not be considered reason for undercut of trench bottom.
- D. The Contractor shall maintain the pumps for the duration of their need including a satisfactory discharge outlet. Power for the pumps shall be electric unless otherwise approved by the Engineer. Noise abatement may be required for any on-site generators in residential areas.

3.6 BEDDING FOR LAYING CONDUIT

- A. Bedding shall conform to the requirements of the plan detail unless otherwise modified by the Engineer.
- B. All granular bedding material shall be compacted to 95 percent of maximum laboratory dry density.
- C. All pipe bedding shall be of the gradation(s) specified and be limestone. Slag may not be used and gravel may be used with permission of the Engineer.

3.7 LAYING CONDUIT

- A. Except as otherwise permitted by the Engineer, all conduit shall be laid starting at the outlet end. Pressure conduits may be laid from either direction however the joints shall be such that the bell is upgrade or toward normal pressure.

- B. Line and grade for gravity conduits shall be established by the use of sufficient means to maintain acceptable installation tolerances and allow for reasonable checking observation by the Engineer.
- C. Line and grade shall be established and maintained over a length of fifty (50) feet minimum. Cut sheets establishing grade at fifty (50) foot intervals shall be provided to the Engineer prior to beginning work.
- D. The Contractor shall provide sufficient equipment and workers to safely handle and lay all conduit included as part of this work. All storage of materials shall be in a manner as to avoid damage to either surface prior to placement.
- E. The Contractor shall inspect each piece of conduit prior to placement in the trench and any unsatisfactory conduit shall be rejected.
- F. Conduit shall not be laid in water, mud, or any otherwise unsuitable trench. The conduit shall not be pushed into or allowed to fall to the bottom of the trench. Handling of the conduit shall be in conformance to the manufacturer's recommendations.
- G. The conduit shall be kept clean and any open ends of installed conduit shall be closed when work is not in progress.
- H. Jointing of the conduit shall be in accordance to the requirements of the manufacturers and as required by the specification material type. Any deviation from these acceptable methods requires approval of the Engineer.
- I. Testing of joints, where required, shall be done in accordance with the Specification for Testing. Should any section fail to meet test requirements, the Contractor shall make suitable corrections, at their cost, until the requirements are met.

3.8 SERVICE CONNECTIONS

- A. In general, and as called for on the drawings, as required or as ordered, provision shall be made in the sewers for service connections by inserting a wye branch for each service connection with a branch size called for by the contract drawings but never less than six (6) inch, in the sewer at location shown, where required or ordered, for sewers to ten (10) feet in depth. For sewers exceeding ten (10) feet in depth, or indicated on the plans, the Contractor shall construct a riser, as per detail, in such manner, that the top of the riser shall be not less than seven (7) feet below grade or at such elevation as to properly receive the required service connection, with full regard to elevation of service sewer and slope from building or structure to the sewer which shall not be less than one percent (1%). Risers are to be encased in sonotube filled with No. 57 Limestone as shown on the contract drawings.
- B. The location of service connections is shown in a general way on the contract drawings. The Owner may also increase the number of connections or delete some connections as the sewer is being built, or increase the size of connections when it deems such advisable.

3.9 FINAL BACKFILL

- A. Final backfill shall be installed from the top of the Pipe Embedment to the final grade. Final backfill of all conduit trenches shall conform to the requirements of the plans and details, Section 312323.13 "Compacted Backfill", and Section 312323.14 "Compacted Granular Backfill". All final backfill under existing or proposed pavement or structures or within the 1:1 zone of influence of existing or proposed pavement or structures shall be "Compacted Granular Backfill". All final backfill not under existing or proposed pavement or structures or within the 1:1 zone of influence of proposed pavement or structures shall be "Compacted Backfill".
- B. Unless otherwise directed, all forms, bracing and lumber shall be removed during backfilling and the cavities and voids resulting from the removal shall be backfilled and compacted to 100% of Standard Proctor.
- C. The Contractor must use special care in placing backfill so as to avoid injuring or moving the conduit or structure when compacting the backfill.
- D. In areas used for temporary maintenance of traffic the top layer of final backfill from the elevation of the existing subbase base interface to the existing or proposed surface(s), shall be ODOT Item 304 Aggregate Base to provide a temporary surface traffic course.
- E. Should after settlement occur, the Contractor must add and compact additional material.
- F. Machine mounted mechanical tamper shall be used for backfill compaction. Flooding, jetting or puddling of backfill will not be permitted.
- G. Excavated material in excess of that needed for backfilling and all unsuitable material shall be disposed of by the Contractor at his own expense and the cost of such disposal shall be included in the unit or lump sum prices bid.

3.10 TESTING AND ACCEPTANCE

- A. Prior to final acceptance of the conduit or the placing of the conduit into service, testing and/or televising may be required.
- B. For all sanitary, water, or other pressured conduits, pressure testing shall be required in accordance to the specifications contained herein. Televising shall be required for all sanitary sewer and may be required for storm sewers as outlined or required by plan note.
- C. Final television inspection of conduit shall be performed by an experienced company and in a format satisfactory to the Owner. Televising shall be done in the presence of the Engineer unless so waived. The Engineer shall be provided with unedited video tapes and two (2) copies of the video log.
- D. Televising shall not be done until all known repairs are completed and the line has been suitably flushed.

3.11 SITE RESTORATION

- A. Restoration of the disturbed project area shall begin immediately after backfilling has been completed. All excess material, debris, and excavation shall be disposed of by the Contractor.
- B. Restoration of paved surfaces and of seeded areas shall be done as soon as conditions permit. The manner in which this work shall be done is defined in other specifications or the contract plans.
- C. While payment for site restoration may be included in other items, final acceptance of the underground conduit shall not occur until all work is complete. Where no separate pay items exist for restoration work, the Engineer may determine an appropriate value for this work to be retained until its completion.

END OF SECTION 312333

SECTION 312514.16 - EROSION CONTROL MATTING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

1.2 SUMMARY

- A. This section includes provisions for the following items:
 - 1. Temporary erosion control.
 - 2. Permanent erosion control.

1.3 QUALITY ASSURANCE

- A. In addition to requirements of these specifications, comply with manufacturer's instructions and recommendations for work.
- B. Subcontract landscape work to a single firm specializing in landscape work.

1.4 SUBMITTALS

- A. Product Data: Submit manufacturer's technical data and application instructions.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Temporary erosion control.
 - 1. Erosion control fabric shall be Hold/Gro as manufactured by:
Erosion Control Systems, Inc. and supplied by:
Erosion Supply Company, Inc.
P.O. Box 21374
South Euclid, Ohio 44121
(216) 381-5989
 - 2. Fabric characteristics
 - a. Material:
 - 1) Yarn - Photodegradable synthetic types
 - 2) Filler - Biodegradable paper
 - b. Dimensional:

<u>Width</u>	<u>Length</u>	<u>Sq.Yds.</u>
56" + 1"	580'	300
113" + 1"	575'	600

B. Permanent erosion control.

1. Erosion control fabric shall be 7020 Enkamat, as manufactured by Basf Corporation Fibers Division and supplied by:
Erosion Control Company, Inc.
P.O. Box 21374
South Euclid, Ohio 44121
(216) 381-5989
2. Matting characteristics
 - a. Material:
 - 1) Nylon 6 + 0.5% by weight Carbon Black
 - b. Dimensional:
 - 1) Weight (g/sq.m.) 405 ± 7%
 - 2) Thickness (mm) (Minimum) 18 (0.8in.)
 - 2) Width (cm) 97 (38 inc.)
 - 3) Roll Length (m) 100 (330 ft.)
 - 4) Filament Dia. (mm) (Minimum) 0.40
 - c. Tensile Properties:
 - 1) ASTM 01682
 - d. Strength (kg/M - minimum):
 - 1) Length Direction 140
 - 2) Width Direction 80
 - e. Elongation (% - minimum):
 - 1) Length Direction 50
 - 2) Width Direction 50
 - f. Resiliency:
 - 1) Immediate recovery
3 cycles at 100 psi 80
 - g. Exposure Properties:
 - 1) Temperature range for 80%
strength retention -100° to 250°F
 - 2) pH range for 80%
strength retention 3 to 12

PART 3 - EXECUTION

3.1 EROSION CONTROL MATTING

- A. Hold/Gro shall be placed over the slopes immediately following fine grading and seeding, on areas indicated on the drawings.
- B. Enkamat shall be placed on areas indicated on the drawings, immediately following placement and stapling of Hold/Gro.
- C. Install both Hold/Gro and Enkamat as per manufacturer's instructions and specifications.
- D. Stakes for Enkamat shall be pine.

PART 4 - PAYMENT

- A. Payment shall be based on unit price bid per square yard.
- B. Payment shall be made for only those areas indicated on the improvement plans. All additional areas disturbed shall be protected at the Contractor's expense.

END OF SECTION 312514.16

SECTION 321000 - PAVEMENT REPLACEMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

1.2 DESCRIPTION OF WORK

- A. The Contractor shall furnish all of the equipment, labor and materials necessary to install, replace, and/or restore existing pavement structures together with their respective appurtenances as shown on the plans and as specified herein. This work shall include all of the subgrade preparation, subbase, base, intermediate pavement course(s), and finish pavement courses together with curbing, guttering, tack and/or prime coating, sealing and other pertinent work as necessary to meet the conditions of this contract.

1.3 QUALITY ASSURANCE

- A. In addition to requirements of these specifications, comply with manufacturer's instructions and recommendations for work.

1.4 REPAIR OR REPLACEMENT WORK

- A. For the repair and/or replacement of all existing pavement structures and their respective appurtenances that are removed and destroyed or otherwise damaged by the Contractor in the course of his performance of the work required under this contract, the Contractor shall furnish all equipment, labor, and materials as necessary to properly restore to a condition equal to that at his entry, and to the satisfaction of the Engineer, the Ohio Department of Transportation, the County Engineer, City Engineer, all cinder, slag, gravel, water-bound macadam, bituminous macadam, asphalt and brick or concrete driveways, curbs, sidewalks and roadways in strict accordance with the drawings and as specified herein.
- B. In general, this item will include concrete, steel reinforcement, brick, stone, slag, cinders, gravel, asphalt and other bituminous materials and curbs, gutters, driveway culverts, road and curb drains and the demolition, excavation and removal of existing driveways, sidewalks and roadways.

1.5 REFERENCE TO OTHER PARTS

- A. Other sections of these specifications shall apply, as and where applicable to this section and such sections will be the same as though they were included in this section.
- B. For all old work where pavement is being repaired and/or replaced as a result of damages occurring thereto during the course of the work of this contract, all clearing and grubbing,

removal and storage of topsoil, excavation and/or placing of compacted fill and granular backfill, shall be done as required under other parts of these specifications.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Generally, for all repair and replacement work, all new materials shall match the existing and adjoining work in both composition and quality unless otherwise ordered, specified herein, and/or shown on the drawings. In any stone driveway or roadway, the material used for stone fill shall conform to the existing material.

PART 3 - EXECUTION

3.1 CONSTRUCTION

- A. All pavement work shall be done in strict accordance with the specifications of the governmental body concerned and the latest ODOT specifications as applicable or at the direction of the Engineer.
- B. All pavements disturbed by the Contractor's operations shall be relaid to the thickness of the adjoining pavement and, in all cases, the restoring of pavements, shall apply both to foundation courses and to the wearing surface.
- C. Should cracks or settlements appear in adjoining pavements, the paving shall be removed to the extent necessary to secure firm and undisturbed bearing and shall be replaced in a satisfactory manner.
- D. No permanent pavement shall be installed, repaired, and/or restored unless, or until, in the opinion of the Engineer, the condition of the backfill is such as to properly support the pavement.
- E. Where new or replacement concrete pavement or base is placed adjacent to existing concrete pavement or base, contraction joints shall be provided in the new or replacement pavement so as to form a continuous joint with that in the existing pavement.

3.2 ROADWAY SUBGRADE

- A. The entire area to be occupied by the roadways and parking areas shall be cleared, topsoil removed and stored, and the excavation or compacted fill made as required and brought to the proper cross-sections. Pipe trenches and other excavations shall be backfilled as required, and thoroughly compacted within the limits of the roadways or parking areas.
- B. After the surface of the subgrade has been properly shaped and before any stone or slag is placed, the entire subgrade shall be thoroughly rolled and compacted to a depth of 12 inches under this section. Rolling shall be done with an approved type of self-propelled roller, weighing not less than ten (10) tons. All hollows and depressions which develop during the rolling shall be filled with acceptable materials, and the subgrade rerolled. The

process of filling and rolling shall be repeated until no depressions develop, and the entire subgrade has been brought to a uniform condition of stability.

- C. All places which, in the opinion of the Engineer cannot be properly rolled, shall be tamped with handheld mechanically or pneumatically powered tampers.
- D. In making the compacted fill and in doing the final subgrade rolling, the Contractor shall see that the material to be compacted and/or rolled has the proper moisture content to secure maximum compaction. When, in the opinion of the Engineer, the material is too wet, the compacting shall be delayed until the material has dried sufficiently. When, in the opinion of the Engineer, the material is too dry, the material shall be sprinkled with water in an amount to secure the proper moisture content.

END OF SECTION 321000

SECTION 323113 – GALVANIZED CHAIN LINK FENCES AND GATES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Chain-link fences.
 - 2. Gates: Motor operated.
- B. Related Sections:
 - 1. Section 030000 Concrete Work.

1.3 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Design chain-link fences and gates, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
 - 1. Minimum Post Size and Maximum Spacing: Determine according to CLFMI WLG 2445, based on mesh size and pattern specified and on the following:
 - a. Wind Loads: 80 mph.
 - b. Fence Height: 6 feet.
 - c. Material: Galvanized Steel
- B. Lightning Protection System: Maximum grounding-resistance value of 25 ohms under normal dry conditions.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated, include construction details, material descriptions, dimensions of individual components, and finishes.
 - 1. Fence and gate posts, rails, and fittings.
 - 2. Chain-link fabric, reinforcements, and attachments.
 - 3. Accessories: Provide privacy slats, barbed wire
 - 4. Gate operators, including operating instructions.
 - 5. Motors: Show nameplate data, ratings, characteristics, and mounting arrangements.
- B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work. Show accessories, hardware, gate operation, and operational clearances.
 - 1. Gate Operator: Show locations and details for installing operator components, switches, and controls. Indicate motor size, electrical characteristics, drive arrangement, mounting, and grounding provisions.
 - 2. Wiring Diagrams: For power, signal, and control wiring.

- C. Samples for Initial Selection: For components with factory-applied color finishes.
- D. Samples for Verification: Prepared on Samples of size indicated below:
 - 1. Polymer-Coated Components: In 6 inch lengths for components and on full-sized units for accessories.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified professional engineer, testing agency and service representative.
- B. Product Certificates: For each type of chain-link fence, operator and gate, from manufacturer.
- C. Product Test Reports: For framing strength according to ASTM F 1043.
- D. Field quality-control reports.
- E. Warranty: Sample of special warranty.

1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For the following to include in emergency, operation, and maintenance manuals:
 - 1. Polymer finishes.
 - 2. Gate hardware.
 - 3. Gate operator.

1.7 QUALITY ASSURANCE

- A. Testing Agency Qualifications: For testing fence grounding. Member Company of NETA or an NRTL.
 - 1. Testing Agency's Field Supervisor: Currently certified by NETA to supervise on-site testing.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- C. Emergency Access Requirements: Comply with requirements of authorities having jurisdiction for gates with automatic gate operators serving as a required means of access.
- D. Mockups: Build mockups to set quality standards for fabrication and installation.
 - 1. Include 10 foot length of fence.

1.8 PROJECT CONDITIONS

- A. Field Measurements: Verify layout information for chain-link fences and gates shown on Drawings in relation to property survey and existing structures. Verify dimensions by field measurements.

1.9 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace components of chain-link fences and gates that fail in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Faulty operation of gate operators and controls.
 - b. Deterioration of metals, metal finishes, and other materials beyond normal weathering.
 - 2. Warranty Period: Two (2) years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 CHAIN-LINK FENCE FABRIC

- A. General: Provide fabric in one-piece heights measured between top and bottom of outer edge of selvage knuckle or twist. Comply with CLFMI Product Manual and with requirements indicated below:
 - 1. Fabric Height: 6 feet.
 - 2. Steel Wire Fabric: Wire with a diameter of 0.192 inch
 - 3. CLFMI limits wire diameter in first option in first subparagraph below to residential applications, but other standards do not make this distinction.
 - a. Mesh Size: 2 inches
 - b. Zinc-Coated Fabric: ASTM A 392, Type II, 2.0 oz./sq. ft with zinc coating applied after weaving.
 - 1) Color: Selected by Owner complying with ASTM F 934.

2.2 FENCE FRAMING

- A. Posts and Rails: Comply with ASTM F 1043 for framing, including rails, braces, and line; terminal; and corner posts. Provide members with minimum dimensions and wall thickness according to ASTM F 1043 based on the following:
 - 1. Fence Height: 72 inches
 - 2. Light Industrial Strength: Material Group IC-L
 - a. Line Post: 1.9 inches in diameter
 - b. End, Corner and Pull Post: 2.875 inches in diameter
 - 3. Horizontal Framework Members: Rails shall comply with ASTM F 1043.
 - a. Top Rail: 1.66 inches in diameter.
 - 4. Metallic Coating for Steel Framing:
 - a. Type A, consisting of not less than minimum 2.0-oz./sq. ft.
 - 5. Polymer coating over metallic coating.
 - a. Color: Match chain link fence, complying with ASTM F 934.

2.3 TENSION WIRE

- A. Metallic-Coated Steel Wire: 0.177-inch diameter, marcelled tension wire complying with ASTM A 817 and ASTM A 824, with the following metallic coating:
 - 1. Type II, zinc coated (hot dip galvanized) with the following minimum coating weight:

- a. Matching chain-link fabric coating weight.
- B. Polymer-Coated Steel Wire: 0.177-inch diameter, tension wire complying with ASTM F 1664, Class 2 over zinc coated steel wire.
 - 1. Color: Match chain link fence, complying with ASTM F 934.

2.4 SWING GATES

- A. General: Comply with ASTM F 900 for gate posts and swing gate types
 - 1. Gate Leaf Width: 36 for new, in kind for existing.
 - 2. Gate Fabric Height: Match Fence.
- B. Pipe and Tubing Material & Coating – Match Fence
- C. Frame Corner Construction: Welded
- D. Extended Gate Posts and Frame Members: Extend gate posts and frame end members above top of chain-link fabric at both ends of gate frame 12 inches to attach barbed wire assemblies.
- E. Hardware:
 - 1. Hinges: 180-degree inward opening swing.
 - 2. Latches permitting operation from both sides of gate with provision for padlocking accessible from both sides of gate.
 - 3. Padlock and Chain.

2.5 HORIZONTAL-SLIDE GATES

- A. General: Comply with ASTM F 1184 for gate posts and single sliding gate types. Provide automated vehicular gates that comply with ASTM F 2200.
 - 1. Classification: Type II Overhead Slide.
 - a. Gate Leaf Width: As indicated.
 - b. Gate Fabric Height: 72 inches
- B. Pipe and Tubing:
 - 1. Zinc-Coated Steel: Protective coating and finish to match fence framing
- C. Frame Corner Construction: Welded.

2.6 FITTINGS

- A. General: Comply with ASTM F 626.
- B. Post Caps: Provide for each post.
 - 1. Provide line post caps with loop to receive tension wire or top rail.
- C. Rail and Brace Ends: For each gate, corner, pull, and end post.
- D. Rail Fittings: Provide the following:

1. Top Rail Sleeves pressed steel not less than 6" long.
 2. Rail Clamps: Line and corner boulevard clamps for connecting rails in the fence line-to-line posts.
- E. Tension and Brace Bands: Pressed steel
- F. Tension Bars: Steel, length not less than 2 inches shorter than full height of chain-link fabric. Provide one bar for each gate and end post, and two for each corner and pull post, unless fabric is integrally woven into post.
- G. Truss Rod Assemblies: Hot dip galvanized steel rod and turnbuckle or other means of adjustment after threading.
- H. Barbed Wire Arms: Pressed steel, with clips, slots, or other means for attaching strands of barbed wire; for each post unless otherwise indicated, and as follows:
1. Provide line posts with arms that accommodate top rail or tension wire.
 2. Provide corner arms at fence corner posts, unless extended posts are indicated.
 3. Type I, single slanted arm.
- I. Tie Wires, Clips, and Fasteners: According to ASTM F 626.
1. Standard Round Wire Ties: For attaching chain-link fabric to posts, rails, and frames, complying with the following:
 - a. Hot-Dip Galvanized Steel: 0.148-inch diameter wire.
 - b. Polymer coating over metallic coating.

2.7 PRIVACY SLATS

- A. Material: PVC, UV-light stabilized color selected by Owner.

2.8 BARBED WIRE

- A. Polymer-Coated, Galvanized-Steel Barbed Wire: Comply with ASTM F 1665 two-strand barbed wire, 0.080-inch diameter line wire with four-point round galvanized-steel barbs spaced not more than 5 inches o.c.:
1. Polymer Coating: Class 1 over zinc-coated steel wire.
 - a. Color: Match fence, complying with ASTM F 934.

2.9 GATE OPERATORS

- A. General: Provide factory-assembled automatic operating system designed for gate size, type, weight, and operation frequency. Provide operation control system with characteristics suitable for Project conditions, with remote-control stations, safety devices, and weatherproof enclosures; coordinate electrical requirements with building electrical system.
1. Provide operator designed so motor may be removed without disturbing limit-switch adjustment and without affecting auxiliary emergency operator.
 2. Provide operator with UL approved components.
 3. Provide electronic components with built-in troubleshooting diagnostic feature.

4. Provide unit designed and wired for both right-hand/left-hand opening, permitting universal installation.
- B. Comply with NFPA 70.
- C. UL Standard: Fabricate and label gate operators to comply with UL 325.
- D. Motor Characteristics: Sufficient to start, accelerate, and operate connected loads at designated speeds, within installed environment, with indicated operating sequence, and without exceeding nameplate rating or considering service factor. Comply with NEMA MG 1 and the following:
1. Voltage: 208V.
 2. Horsepower: 3/4.
 3. Enclosure: Manufacturer's standard.
 4. Duty: Continuous duty at ambient temperature of 105 deg F and at altitude of 600 feet above sea level.
 5. Service Factor: 1.15.
 6. Phase: Polyphase.
- E. Gate Operators: Mountings and as follows:
1. Mechanical Slide Gate Operators:
 - a. Duty: Heavy duty, commercial/industrial.
 - b. Gate Speed: 45 feet per minute
 - c. Frequency of Use: Continuous duty.
 - d. Operating Type: Wheel and rail drive with manual release.
 - e. Drive Type: Enclosed worm gear and chain-and-sprocket reducers, roller-chain drive.
- F. Remote Controls: Electric controls separated from gate and motor and drive mechanism, with NEMA 3Rv, pedestal mounting and with space for additional optional equipment. Provide the following remote-control device(s):
1. Control Station: Momentary-contact, three-button-operated; located remotely from gate. Key switch to lock out open and close buttons.
 - a. Function: Open, Stop and Close.
 2. Card Reader: Functions only when authorized card is presented. Programmable, magnetic single code system, face-lighted unit fully visible at night.
 - a. Reader Type: Proximity.
 - b. Features: Limited-time usage
 3. Digital Keypad Entry Unit: Multiple-programmable, code capability of not less than five possible individual codes, consisting of one- to seven digit codes.
 - a. Features: Limited-time usage
 - b. Face-lighted keypad fully visible at night.
 4. Vehicle Loop Detector: System including automatic closing timer with adjustable time delay before closing, timer cut-off switch, and loop detector designed to open and close gate, and hold gate open until traffic clears. Provide electronic detector with adjustable detection patterns, adjustable sensitivity and frequency settings, and panel indicator light designed to detect presence or transit of a vehicle over an

embedded loop of wire and to emit a signal activating the gate operator. Provide number of loops consisting of multiple strands of wire, number of turns, loop size, and method of placement at location shown on Drawings, as recommended in writing by detection system manufacturer for function indicated.

- a. Loop: Wire, in size indicated for field assembly, for saw-cut with epoxy-grouted installation.
5. Vehicle Presence Detector: System including automatic closing timer with adjustable time delay before closing, and presence detector designed to open and close gate hold gate open until traffic clears and reverse gate. Provide detector with adjustable detection zone pattern and sensitivity, designed to detect the presence or transit of a vehicle in gate pathway when infrared beam in zone pattern is interrupted, and to emit a signal activating the gate operator.
- G. Obstruction Detection Devices: Provide each motorized gate with automatic safety sensor(s). Activation of sensor(s) causes operator to immediately function as follows:
1. Action: Reverse gate in both opening and closing cycles and hold until clear of obstruction.
 2. Internal Sensor: Built-in torque or current monitor senses gate is obstructed.
 3. Sensor Edge: Contact-pressure-sensitive safety edge, profile, and sensitivity designed for type of gate and component indicated, in locations as follows. Connect to control circuit using take-up cable reel.
 4. Photoelectric/Infrared Sensor System: Designed to detect an obstruction in gate's path when infrared beam in the zone pattern is interrupted.
- H. Limit Switches: Adjustable switches, interlocked with motor controls and set to automatically stop gate at fully retracted and fully extended positions.
1. Type: Mechanical device, key, or crank-activated release.
- I. Operating Features:
1. Digital Microprocessor Control: Electronic programmable means for setting, changing, and adjusting control features with capability for monitoring and auditing gate activity. Provide unit that is isolated from voltage spikes and surges.
 2. System Integration: With controlling circuit board capable of accepting any type of input from external devices.
 3. Automatic Closing Timer: With adjustable time delay before closing and timer cut-off switch.
 4. Open Override Circuit: Designed to override closing commands.
 5. Reversal Time Delay: Designed to protect gate system from shock load on reversal in both directions.
 6. Maximum Run Timer: Designed to prevent damage to gate system by shutting down system if normal time to open gate is exceeded.
 7. Clock Timer: 24-hour, Seven-day programmable.
- J. Accessories:
1. Warning Module: Audio alarm sounding three to five seconds in advance of gate operation and continuing until gate stops moving; compliant with the U.S. Architectural & Transportation Barriers Compliance Board's ADA-ABA Accessibility Guidelines.
 2. Postal box.

3. Intercom System.
4. Instructional, Safety, and Warning Labels and Signs: As recommended.
5. Equipment Bases/Pads: Cast-in-place or precast concrete base to 36" depth, dimensioned and reinforced according to gate-operator component manufacturer's written instructions and as indicated on Drawings.

2.10 GROUT AND ANCHORING CEMENT

- A. Nonshrink, Nonmetallic Grout: Premixed, factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C 1107. Provide grout, recommended in writing by manufacturer, for exterior applications.
- B. Erosion-Resistant Anchoring Cement: Factory-packaged, nonshrink, nonstaining, hydraulic-controlled expansion cement formulation for mixing with potable water at Project site to create pourable anchoring, patching, and grouting compound. Provide formulation that is resistant to erosion from water exposure without needing protection by a sealer or waterproof coating and that is recommended in writing by manufacturer, for exterior applications.

2.11 FENCE GROUNDING

- A. Conductors: Bare, solid wire for No. 6 AWG and smaller; stranded wire for No. 4 AWG and larger.
 1. Material above Finished Grade: Copper.
 2. Material on or below Finished Grade: Copper.
 3. Bonding Jumpers: Braided copper tape, 1 inch, woven of No. 30 AWG bare copper wire, terminated with copper ferrules.
- B. Connectors and Grounding Rods: Comply with UL 467.
 1. Connectors for Below-Grade Use: Exothermic welded type.
 2. Grounding Rods: Copper-clad steel, 5/8 by 96 inches.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and conditions, with Installer present, for compliance with requirements for a verified survey of property lines and legal boundaries, site clearing, earthwork, pavement work, and other conditions affecting performance of the Work.
 1. Do not begin installation before final grading is completed unless otherwise permitted by Architect.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Stake locations of fence lines, gates, and terminal posts. Indicate locations of utilities, lawn sprinkler system, underground structures, benchmarks, and property monuments.

3.3 INSTALLATION, GENERAL

- A. Install chain-link fencing to comply with ASTM F 567 and more stringent requirements indicated.
 - 1. Install fencing on established boundary lines inside property line where applicable.

3.4 CHAIN-LINK FENCE INSTALLATION

- A. Post Excavation: Drill or hand-excavate holes for posts to diameters and spacing indicated, in firm, undisturbed soil.
- B. Post Setting: Set posts mechanically driving into soil at indicated spacing into firm, undisturbed soil except at gate locations where they shall be concrete encased.
 - 1. Verify that posts are set plumb, aligned, and at correct height and spacing, and hold in position during setting with concrete or mechanical devices.
 - 2. Concrete Fill: Place concrete around posts to dimensions indicated and vibrate or tamp for consolidation. Protect aboveground portion of posts from concrete splatter.
 - a. Exposed Concrete: Extend 2 inches above grade; shape and smooth to shed water.
 - 3. Mechanically Driven Posts: Drive into soil to depth of 36 inches. Protect post top to prevent distortion.
- C. Terminal Posts: Locate terminal end, corner, and gate posts per ASTM F 567 and terminal pull posts at changes in horizontal or vertical alignment of 30 degrees or more.
- D. Line Posts: Space line posts uniformly at 10 feet.
- E. Post Bracing and Intermediate Rails: Install according to ASTM F 567, maintaining plumb position and alignment of fencing. Diagonally brace terminal posts to adjacent line posts with truss rods and turnbuckles. Install braces at end and gate posts and at both sides of corner and pull posts.
 - 1. Locate horizontal braces at mid-height of fabric. Install so posts are plumb when diagonal rod is under proper tension.
- F. Tension Wire: Install according to ASTM F 567, maintaining plumb position and alignment of fencing. Pull wire taut, without sags. Fasten fabric to tension wire with hog rings of same material and finish as fabric wire, spaced a maximum of 24 inches o.c. Install tension wire in locations indicated before stretching fabric. Provide horizontal tension wire at the following locations:
 - 1. Extended along top and bottom of fence fabric. Install top tension wire through post cap loops. Install bottom tension wire within 6 inches of bottom of fabric and tie to each post with not less than same diameter and type of wire.
 - 2. Extended along top of barbed wire arms extended posts and top of fence fabric for supporting barbed tape.
- G. Top Rail: Install according to ASTM F 567, maintaining plumb position and alignment of fencing. Run rail continuously through line post caps, bending to radius for curved runs and terminating into rail end attached to posts or post caps fabricated to receive rail

at terminal posts. Provide expansion couplings as recommended in writing by fencing manufacturer.

- H. Intermediate and Bottom Rails: Install and secure to posts with fittings.
- I. Chain-Link Fabric: Apply fabric to outside of enclosing framework. Leave 1 inch between finish grade or surface and bottom selvage unless otherwise indicated. Pull fabric taut and tie to posts, rails, and tension wires. Anchor to framework so fabric remains under tension after pulling force is released.
- J. Tension or Stretcher Bars: Thread through fabric and secure to end, corner, pull, and gate posts with tension bands spaced not more than 15 inches o.c.
- K. Tie Wires: Use wire of proper length to firmly secure fabric to line posts and rails. Attach wire at one end to chain-link fabric, wrap wire around post a minimum of 180 degrees, and attach other end to chain-link fabric per ASTM F 626. Bend ends of wire to minimize hazard to individuals and clothing.
 - 1. Maximum Spacing: Tie fabric to line posts at 12 inches o.c. and to braces at 24 inches o.c.
- L. Privacy Slats: Install slats in direction indicated, securely locked in place.
 - 1. Diagonally, for privacy factor of 80 to 85
- M. Barbed Wire: Install barbed wire uniformly spaced, angled toward security side of fence. Pull wire taut, install securely to extension arms, and secure to end post or terminal arms.

3.5 GATE INSTALLATION

- A. Install gates according to manufacturer's written instructions, level, plumb, and secure for full opening without interference. Attach fabric as for fencing. Attach hardware using tamper-resistant or concealed means. Install ground-set items in concrete for anchorage. Adjust hardware for smooth operation and lubricate where necessary.

3.6 GATE OPERATOR INSTALLATION

- A. General: Install gate operators according to manufacturer's written instructions, aligned and true to fence line and grade.
- B. Excavation for Support Posts and Pedestals: Hand-excavate in firm, undisturbed soil to dimensions and depths and at locations as required by gate-operator component manufacturer's written instructions and as indicated.
- C. Vehicle Loop Detector System: Cut grooves in pavement and bury and seal wire loop according to manufacturer's written instructions. Connect to equipment operated by detector.
- D. Comply with NFPA 70 and manufacturer's written instructions for grounding of electric-powered motors, controls, and other devices.

3.7 GROUNDING AND BONDING

- A. Fence Grounding: Install at maximum intervals of 1500 feet except as follows:
 - 1. Fences within 100 Feet of Buildings, Structures, Walkways, and Roadways: Ground at maximum intervals of 750 feet.
 - a. Gates and Other Fence Openings: Ground fence on each side of opening.
 - 1) Bond metal gates to gate posts.
 - 2) Bond across openings, with and without gates, except openings indicated as intentional fence discontinuities. Use No. 2 AWG wire and bury it at least 18 inches below finished grade.
- B. Protection at Crossings of Overhead Electrical Power Lines: Ground fence at location of crossing and at a maximum distance of 150 feet on each side of crossing.
- C. Fences Enclosing Electrical Power Distribution Equipment: Ground as required by IEEE C2 unless otherwise indicated.
- D. Grounding Method: At each grounding location, drive a grounding rod vertically until the top is 6 inches below finished grade. Connect rod to fence with No. 6 AWG conductor. Connect conductor to each fence component at the grounding location, including the following:
 - 1. Make grounding connections to each barbed wire strand with wire-to-wire connectors designed for this purpose.
 - 2. Make grounding connections to each barbed tape coil with connectors designed for this purpose.
- E. Bonding Method for Gates: Connect bonding jumper between gate post and gate frame.
- F. Connections: Make connections to minimize possibility of galvanic action or electrolysis. Select connectors, connection hardware, conductors, and connection methods so metals in direct contact will be galvanically compatible.
 - 1. Use electroplated or hot-tin-coated materials to ensure high conductivity and to make contact points closer in order of galvanic series.
 - 2. Make connections with clean, bare metal at points of contact.
 - 3. Make aluminum-to-steel connections with stainless-steel separators and mechanical clamps.
 - 4. Make aluminum-to-galvanized-steel connections with tin-plated copper jumpers and mechanical clamps.
 - 5. Coat and seal connections having dissimilar metals with inert material to prevent future penetration of moisture to contact surfaces.
- G. Bonding to Lightning Protection System: If fence terminates at lightning-protected building or structure, ground the fence and bond the fence grounding conductor to lightning protection down conductor or lightning protection grounding conductor complying with NFPA 780.

3.8 FIELD QUALITY CONTROL

- A. Grounding-Resistance Testing: Owner will engage a qualified testing agency to perform tests and inspections.

1. Grounding-Resistance Tests: Subject completed grounding system to a megger test at each grounding location. Measure grounding resistance no fewer than two full days after last trace of precipitation, without soil having been moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural grounding resistance. Perform tests by two-point method according to IEEE 81.
2. Excessive Grounding Resistance: If resistance to grounding exceeds specified value, notify Architect promptly. Include recommendations for reducing grounding resistance and a proposal to accomplish recommended work.
3. Report: Prepare test reports certified by a testing agency of grounding resistance at each test location. Include observations of weather and other phenomena that may affect test results.

3.9 ADJUSTING

- A. Gates: Adjust gates to operate smoothly, easily, and quietly, free of binding, warp, excessive deflection, distortion, nonalignment, misplacement, disruption, or malfunction, throughout entire operational range. Confirm that latches and locks engage accurately and securely without forcing or binding.
- B. Automatic Gate Operator: Energize circuits to electrical equipment and devices. Adjust operators, controls, safety devices, alarms, and limit switches.
 1. Hydraulic Operator: Purge operating system, adjust pressure and fluid levels, and check for leaks.
 2. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
 3. Test and adjust controls, alarms, and safeties. Replace damaged and malfunctioning controls and equipment.
- C. Lubricate hardware, gate operator, and other moving parts.

3.10 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's personnel to adjust, operate, and maintain chain-link fences and gates.

END OF SECTION 323113

SECTION 329200.19 – SODDING, SEEDING AND MULCHING

PART 1 - GENERAL

1.1 SUMMARY

- A. Installation of seeded areas shall be to the extent shown on Contract Drawings and shall include supplying all seed, topsoil, soil materials, mulching materials and watering, and the incorporation of these materials into the work as specified.
- B. The Contractor shall place topsoil at the depths specified in those areas requiring seeding. Topsoil shall be furnished by the Contractor.

1.2 SUBMITTALS

- A. Product Data: For the following:
 - 1. Provide copies of soils tests for both new topsoil (provided) and onsite topsoil for review and approval. This applies to all areas that require seeding, including reconditioned areas.
 - 2. Provide location of properties from which topsoil is to be obtained, names and addresses of owners, depth to be stripped, and crops grown in the past 2 years.
 - 3. Provide the name of the seed supplier, name and phone number, list of the seed, including varieties of seed, labels, and an analysis of the seed for review, 4 weeks prior to the start of seeding.
 - 4. Provide soil amendments information based on soils test requirements.
 - 5. Hydroseed mixture, mulch and application rates prior to performing the work.

1.3 QUALITY ASSURANCE

- A. Any subcontracted restoration work shall be performed by a qualified firm specializing in landscape work.
- B. The Contractor shall have a soils test done at his expense and analyzed by a state approved testing agency. Soil tests shall be done on both the topsoil stockpiled from the site and new topsoil brought to the site. A minimum of two (2) tests shall be done. The tests shall include percent organic matter, pH, Buffer pH, Phosphorus, Exchangeable Potassium, Calcium, Magnesium, Cation Exchange Capacity and Percent Base Saturation with recommendations for nitrogen, phosphate, potash, magnesium and lime based on plant type and use.
- C. Seed: All seed specified shall meet ODOT specifications as to the percentage purity, weed seed, and germination. All seed shall be approved by the State of Ohio, Department of Agriculture, Division of Plant Industry, and shall meet the requirements of these specifications.
- D. Packaged Materials: Deliver packaged materials in containers showing weight, analysis, and name of manufacturer. Protect materials from deterioration during delivery, and while stored at site.

1.4 PROJECT CONDITIONS

- A. Utilities: Determine location of underground utilities and perform work in a manner which will avoid possible damage. Hand excavate, as required. Maintain grade stakes set by others until removal is mutually agreed upon by parties concerned.
- B. Excavation: When conditions detrimental to plant growth are encountered, such as rubble fill, adverse drainage conditions, or obstructions, such conditions shall be rectified by the Contractor before planting, with approval from the Owner's Representative.
- C. Soil Stabilization: The Contractor shall provide permanent or temporary soil stabilization to denuded areas within fifteen (15) days after final grade is reached on any portion of the site. Any such area which will not be regraded for longer than fifteen (15) days shall also be stabilized. Soil stabilization includes any measures which protect the soil from the erosive forces of raindrop impact and flowing water. Applications include seeding and/or mulching, or the use of other erosion control measures as directed by the Owner's Representative. If necessary, the Contractor shall coordinate soil stabilization practices with the local Soil and Water Conservation District.
- D. Spring-sown work shall be installed between April 1st and May 30th and Fall-sown work shall be installed between September 1st and October 15th. No permanent seeding shall take place between May 30th and September 1st and between October 15th and April 1st. The dates for seeding may be changed at the discretion of the Owner's Representative.

PART 2 - PRODUCTS

2.1 TOPSOIL

- A. Topsoil shall be furnished by the Contractor. Stockpiled material, if any, shall be utilized prior to obtaining additional topsoil.
- B. All topsoil shall conform to the U.S. Department of Agriculture soil texturing triangle and shall contain between 3% to 8% organic matter. Topsoil shall be loamy and not consist of more than 38% clay. New topsoil shall be screened to remove clay lumps, brush, weeds, litter, roots, stumps, stones larger than 1/2" in any dimension and any other extraneous or toxic matter harmful to plant growth.
- C. New topsoil shall be obtained only from naturally well drained sites where topsoil occurs in a depth of not less than 4". Do not obtain from bogs or marshes.
- D. Soil amendments shall be added according to the soils test requirements. Amendments can include, but are not limited to fertilizer, lime, compost, sand, and organic matter. Organic matter shall consist of composted leaves or other approved material.

2.2 SEED

- A. Seed shall be vendor mixed, delivered in original bags and shall be proportioned as follows:

<u>Common Name</u>	<u>Proportion by Weight</u>
Kentucky Bluegrass	40%
Penn Lawn Fescue	40%
Perennial Rye	20%

2.3 MULCH

- A. Mulch shall be clean straw free of seed and weed seed.
1. Anchoring for mulch shall be an ODOT specified SS-1 at 60 gal./ton non-toxic tackifier such as Hydro-stik, or equal, or by securing with a photo degradable netting.
- B. If hydroseeding is used, wood fiber mulching material shall be used and shall consist of virgin wood fibers manufactured expressly from whole wood chips and shall conform to the following specifications.
1. Moisture content $10.0\% \pm 3.0\%$
 2. Organic content $99.2\% \pm 0.8\%$ O.D. Basis
 3. pH 4.8 ± 0.5
 4. Water holding capacity, minimum 1,000 (grams of water per 100 grams of fiber)

Wood fiber mulching material shall be processed in such a manner as to contain no growth or germination inhibiting factors and must contain a biodegradable green dye to aid in visual metering during application.

PART 3 - EXECUTION

3.1 PREPARATION - GENERAL

- A. Rough grading to a depth necessary to accept the specified thickness of topsoil must be approved prior to placing topsoil.
- B. Loosen subgrade, remove any stones greater than 1/2" in any dimension. Remove sticks, roots, rubbish, and other extraneous matter.
- C. Spread topsoil to a minimum depth of 4 inches, to meet lines, grades, and elevations shown on plan, after light rolling and natural settlement. Remove sticks, roots, rubbish, stones greater than 1/2" in any dimension, and other extraneous matter. Topsoil shall be tilled thoroughly by plowing, disking, harrowing, or other approved methods. Add specified soil amendments and mix thoroughly into the topsoil.
- D. Preparation of Unchanged Grades: Where seed is to be planted in areas that have not been altered or disturbed by excavating, grading, or stripping operations, prepare soil for planting as follows: Till to a depth of not less than 6 inches. Apply soil amendments

and initial fertilizers as specified. Remove high areas and fill in depressions. Till soil to a homogenous mixture of fine texture, free of lumps, clods, stones, roots and other extraneous matter. Soils test requirements apply here as well.

1. Prior to preparation of unchanged areas, remove existing grass, vegetation and turf. Dispose of such material outside of project limits. Do not turn existing vegetation over into soil being prepared for seed.
 2. If necessary, supply and install topsoil in areas where there is no topsoil left after vegetation has been removed.
 3. Apply specified soil amendments at rates specified in the soils test and thoroughly mix into upper 2 inches of topsoil. Add topsoil if existing grade has less than 4" of topsoil. Delay application of amendments if planting will not follow within two (2) days.
- E. Fine grade areas to smooth, even surface with loose, uniformly fine texture. Roll, rake, and drag lawn areas, remove ridges and fill depressions, as required to meet finish grades. Remove sticks, roots, rubbish, stones greater than 1/2" in any dimension, and other extraneous matter. Limit fine grading to areas which can be planted immediately after grading.
- F. Moisten prepared areas before planting if soil is dry. Water thoroughly and allow surface moisture to dry before planting lawns. Do not create a muddy soil condition.
- G. Restore areas to specified condition, if eroded or otherwise disturbed, after fine grading and prior to planting.

3.2 SEEDING

- A. Do not use wet seed or seed that is moldy or otherwise damaged in transit or storage. Seed shall not be sown when the ground is frozen, muddy, or when weather conditions prevent proper soil preparation, interference with sowing and/or proper incorporation of seed into the soil.
- B. Sow seed using a spreader or hydroseeder. Do not seed when wind velocity exceeds 5 miles per hour. Distribute seed evenly over entire area by sowing 3 lbs. per 1000 S.F. at right angles to each other. Total amount to equal a minimum of 6 lbs. per 1000 S.F.
- C. For seed sown with a spreader, mulch shall be spread uniformly to form a continuous blanket at a rate of 100 lbs. per 1,000 S.F. Mulch shall be 1 1/2" loose measurement over seeded areas and shall be anchored.
- D. Contractor has the option to hydroseed large lawn areas, using equipment specifically designed for such application. The rate of application of wood fiber mulching materials is 40 lbs./1,000 S.F. Contractor shall not hydroseed within close proximity to buildings and structures, or when unfavorable wind conditions may blow the hydroseed material onto the structure. Contractor shall clean all areas not to be seeded of overspray.
- E. The seeded area shall be watered, as soon as the seed is applied, at the rate of 120 gallons per 1000 square feet. The water shall be applied by means of a hydroseeder or a water tank under pressure with a nozzle that will produce a spray that will not dislodge the

mulching material. Cost of this watering shall be included in the cost of seeding and mulching.

3.3 DORMANT SEEDING METHOD

- A. Seeding shall not take place from October 15 through November 20. During this period prepare the seed bed, add the required amounts of lime and fertilizer, and other amendments, then mulch and anchor.
- B. From November 20 through April 1, when soil conditions permit, prepare the seed bed, lime and fertilize, apply the selected seed mixture, mulch, and anchor. Increase the seeding rate by 50 percent.

3.4 RECONDITIONING EXISTING LAWNS

- A. A soils test shall be required for existing lawns prior to any reconditioning.
- B. Recondition all existing lawn areas damaged by Contractor's operations including storage of materials and equipment and movement of vehicles. Also recondition existing lawn areas where minor regrading is required.
- C. Provide soil amendments as called for in the soils test.
- D. Provide new topsoil, as required, to fill low spots and meet new finish grades.
- E. Cultivate bare and compacted areas according to the topsoil specifications.
- F. Remove diseased and unsatisfactory lawn areas; do not bury into soil. Remove topsoil containing foreign materials resulting from the Contractor's operations, including oil drippings, stone, gravel, and other loose building materials.
- G. All work shall be the same as for new seeding.
- H. Water newly planted seed areas. Maintenance of reconditioned lawns shall be the same as maintenance of new lawns.

3.5 ESTABLISHMENT

- A. Maintain work areas as long as necessary to establish a uniformly close stand of grass over the entire lawn area. A uniformly close stand of grass is defined as the seeded areas having 90%+ coverage of grass at 60 days after seeding. 90%+ coverage is defined as very little or no dirt showing when seeded area is viewed from directly overhead.
- B. Maintain lawns by watering, fertilizing, weeding, mowing, trimming, and other operations such as rolling, regrading and replanting as required to establish a smooth acceptable lawn.
 - 1. Mowing
 - a. Mow lawn areas during the period of maintenance to a height of 2 inches

whenever the height of the grass becomes 3 inches. A minimum of three (3) mowings are required during the period of maintenance.

2. Refertilizing
 - a. Distribute fertilizer on the seeded area between August 15 and October 15, during the period when grass is dry, and in accordance with the manufacturer's recommendations. The fertilizer shall be as specified in the soils test.
3. Reseeding
 - a. Reseed with the seed specified for the original seeding, at the rate of 4 lbs. per 1,000 S.F. in a manner which will cause minimum disturbance to the existing stand of grass and at an angle of not less than 15 degrees from the direction of rows of prior seeding.
4. Watering
 - a. The Contractor shall keep all work areas watered daily to achieve satisfactory growth. Water shall be applied at a rate of 120 gallons per 1,000 square feet.
5. Any mulching which has been displaced shall be repaired immediately. Any seed work which has been disturbed or damaged from the displacement of mulch shall be repaired prior to re-mulching.

3.6 INSPECTION AND ACCEPTANCE

- A. When seeding work is complete and an acceptable stand of growth is attained, the Contractor shall request the Owner's Representative to make an inspection to determine final acceptance.
- B. Acceptance shall be based upon achieving a vigorous uniformly stand of the specified grasses. If some areas are satisfactory and some are not, acceptance may be made in blocks, provided they are definable or bounded by readily identified permanent surfaces, structures, or other reference means. Partial acceptance decisions may be made by the Owner's Representative. Excessive fragmentation into accepted and unaccepted areas shall not be allowed. Unaccepted areas shall be maintained by the Contractor until acceptable.
- C. No payment shall be made until areas are accepted.
- D. All seeded areas shall be guaranteed for one full growing season to commence upon final acceptance of the areas.

END OF SECTION 329200.19

SECTION 330130 - MISCELLANEOUS TEMPORARY FACILITIES

PART 1 - GENERAL

1.1 MAINTENANCE OF SANITARY FLOWS

- A. The Contractor for this contract shall be responsible for maintaining all sanitary flows through the existing sanitary sewerage systems. Provisions shall be made for temporary pumping and/or storage of sanitary flows during periods of sewer and manhole reconstruction, or when flows must be interrupted to make connections to the new facilities as directed by the Engineer.

END OF SECTION 330130

SECTION 330505 – BURIED PIPING INSTALLATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

1.2 DESCRIPTION OF WORK

- A. Contractor shall provide all labor, materials, equipment, and incidentals as shown, specified, and required to install and test all buried piping, fittings, and specials. The Work includes the following:

1. All types and sizes of buried piping, except where buried piping installations are specified under other Sections or other contracts.
2. Unless otherwise shown or specified, this Section includes all buried piping Work required, beginning at the outside face of structures or structure foundations, including piping beneath structures, and extending away from structures.
3. Work on or affecting existing buried piping.
4. Installation of all jointing and gasket materials, specials, flexible couplings, mechanical couplings, harnessed and flanged adapters, sleeves, tie rods, cathodic protection, and other Work required for a complete, buried piping installation.
5. Supports, restraints, and thrust blocks.
6. Pipe encasements, with the exception of piping embedded in concrete within a structure or foundation specified under Section 40 05 05, Exposed Piping Installation.
7. Field quality control, including testing.
8. Cleaning and disinfecting.
9. Incorporation of valves, meters, and special items shown or specified into piping systems in accordance with the Contract Documents and as required.

- B. Coordination

1. Review installation procedures under this and other Sections and coordinate installation of items to be installed with or before buried piping Work.
2. Coordinate with appropriate piping Sections of Division 40, Process Integration.

- C. Related Sections:

1. Division 31 - Earthwork.
2. Section 09 9100 – Painting
3. Division 30 – Utilities
4. Division 40 – Process Integration

1.3 REFERENCES

- A. Standards referenced in this Section are:
 - 1. ASTM D2321, Practice for Underground Installation of Thermoplastic Pipe for Sewers and other Gravity-Flow Applications.
 - 2. ASTM D2774, Practice for Underground Installation of Thermoplastic Pressure Piping.
 - 3. ANSI/AWWA C105, Polyethylene Encasement for Ductile-Iron Pipe Systems.
 - 4. ANSI/AWWA C111, Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
 - 5. ANSI/AWWA C600, Installation of Ductile-Iron Water Mains and Their Appurtenances.
 - 6. AWWA M41, Ductile-Iron Pipe and Fittings.

1.4 QUALITY ASSURANCE

- A. Regulatory Requirements
 - 1. Comply with requirements and recommendations of authorities having jurisdiction over the Work.

1.5 SUBMITTALS

- A. Action Submittals: Submit the following:
 - 1. Shop Drawings:
 - a. Laying schedules for piping with restrained joints.
 - b. Details of piping, specials, joints, harnessing and thrust blocks, and connections to piping, structures, equipment, and appurtenances.
 - 2. Product Data:
 - a. Manufacturer's literature and specifications, as applicable, for products specified in this Section.
 - 3. Testing Procedures:
 - a. Submit proposed testing procedures, methods, apparatus, and sequencing. Obtain Engineer's approval prior to commencing testing.
- B. Informational Submittals: Submit the following:
 - 1. Certificates
 - a. Certificate signed by manufacturer of each product certifying that product conforms to applicable referenced standards.
 - 2. Field Quality Control Submittals:
 - a. Results of each specified field quality control test.
- C. Closeout Submittal: Submit the following:
 - 1. Record Documentation:
 - a. Maintain accurate and up-to-date record documents showing modifications made in the field, in accordance with approved submittals, and other Contract modifications relative to buried piping Work. Submittal shall show actual location of all piping Work and appurtenances at same scale as the Drawings.
 - b. Show piping with elevations referenced to Project datum and dimensions from permanent structures. For each horizontal bend in piping, include dimensions to

at least three permanent structures, when possible. For straight runs of piping provide offset dimensions as required to document piping location.

- c. Include profile drawings with buried piping record documents when the Contract Documents include piping profile drawings.
- d. Conform to Section 01 78 39, Project Record Documents.

1.6 DELIVERY, STORAGE AND HANDLING

A. Delivery

1. Deliver materials to the Site to ensure uninterrupted progress of the Work.
2. Upon delivery inspect pipe and appurtenances for cracking, gouging, chipping, denting, and other damage and immediately remove from Site and replace with acceptable material.

B. Storage

1. Store materials to allow convenient access for inspection and identification. Store material off ground using pallets, platforms, or other supports. Protect packaged materials from corrosion and deterioration.
2. Pipe and fittings other than PVC and CPVC may be stored outdoors without cover. Cover PVC and CPVC pipe and fittings stored outdoors.

C. Handling

1. Handle pipe, fittings, specials, and accessories carefully in accordance with pipe manufacturer's recommendations. Do not drop or roll material off trucks. Do not drop, roll or skid piping.
2. Avoid unnecessary handling of pipe.
3. Keep pipe interiors free from dirt and foreign matter.
4. Protect interior linings and exterior coatings of pipe and fittings from damage. Replace pipe and fittings with damaged lining regardless of cause of damage.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Piping materials are specified in the Buried Piping Schedule at end of this Section. Piping materials shall conform to Specifications for each type of pipe and piping appurtenances in applicable Sections of Division 30 Utilities and Division 40, Process Integration.

B. General:

1. Pipe Markings:
 - a. Factory-mark each length of pipe and each fitting with designation conforming to those on approved laying schedules.
 - b. Manufacturer shall cast or paint on each length of pipe and each fitting pipe material, diameter, and pressure or thickness class.

C. Polyethylene Encasement:

1. Polyethylene may be supplied in tubes or sheets.

2. Polyethylene encasement materials shall be in accordance with ANSI/AWWA C105

2.2 BURIED PIPING IDENTIFICATION

A. Polyethylene Underground Warning Tape for Metallic Pipelines:

1. Tracer tape shall be of inert, acid- and alkali-resistant, polyethylene, four mils thick, six inches wide, suitable for direct burial. Tape shall be capable of stretching to twice its original length.
2. Message shall read, "CAUTION [insert customized name of pipe service, i.e., "POTABLE WATER", "SANITARY SEWER", "CHLORINE GAS", or other service as appropriate, as indicated in the Buried Pipe Schedule at the end of this Section] PIPE BURIED BELOW", with bold letters approximately two inches high. Messages shall be printed at maximum intervals of two feet. Tape shall be custom colored the same as pipeline colors specified for associated pipe service in Section 09 91 00, Painting.
3. Manufacturer: Provide products of one of the following:
 - a. Brady Corporation
 - b. Seton Identification Products
 - c. Marking Services, Inc.
 - d. Or equal.

B. Detectable Underground Warning Tape for Non-Metallic Pipelines:

1. Tape shall be of inert, acid- and alkali-resistant, polyethylene, five mils thick, six inches wide, with aluminum backing, and have 15,000 psi tensile strength and 80 percent elongation capability. Tape shall be suitable for direct burial.
2. Message shall read, "CAUTION [insert customized name of pipe service, i.e., "POTABLE WATER", "SANITARY SEWER", "CHLORINE GAS", or other appropriate service, as indicated in the Buried Pipe Schedule at the end of this Section] PIPE BURIED BELOW" with bold letters approximately two inches high. Messages shall be printed at maximum intervals of two feet. Tape shall be custom colored the same as the pipeline colors as specified for the associated pipe service in Section 09 91 00, Painting.
3. Manufacturer: Provide products of one of the following:
 - a. Brady Corporation
 - b. Seton Identification Products
 - c. Marking Services, Inc.
 - d. Or equal.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General

1. Install piping as shown, specified, and as recommended by pipe and fittings manufacturer.
2. In event of conflict between manufacturer's recommendations and the Contract Documents, request interpretation from Engineer before proceeding.

3. Engineer will observe excavations and bedding prior to laying pipe by Contractor. Notify Engineer in advance of excavating, bedding, pipe laying, and backfilling operations.
4. Minimum cover over buried piping shall be 4 feet, unless otherwise shown or approved by Engineer.
5. Earthwork is specified in Section 31 00 00.
6. Excavation in excess of that required or shown, and that is not authorized by Engineer shall be filled at Contractor's expense with granular material furnished, placed, and compacted in accordance with Division 31, Earthwork.

B. Plugs

1. Temporarily plug installed pipe at end of each day of work or other interruption of pipe installation to prevent entry of animals, liquids, and persons into pipe, and entrance or insertion of deleterious materials into pipe.
2. Install standard plugs in bells at dead ends, tees, and crosses. Cap spigot and plain ends.
3. Fully secure and block plugs, caps, and bulkheads installed for testing to withstand specified test pressure.
4. Where plugging is required for phasing of the Work or subsequent connection of piping, install watertight, permanent type plugs, caps, or bulkhead acceptable to Engineer.

C. Bedding Pipe: Bed pipe as specified and in accordance with details on the Drawings.

1. Trench excavation and backfill, and bedding materials shall conform to Division 31, as applicable.
2. Where Engineer deems existing bedding material unsuitable, remove and replace existing bedding with approved granular material furnished, placed, and compacted in accordance with Section 31 23 05, Excavation and Fill. Payment for additional excavation and providing granular material will be made under the unit price payment items in the Contract.
3. Excavate trenches below bottom of pipe by amount shown and indicated in the Contract Documents. Remove loose and unsuitable material from bottom of trench.
4. Carefully and thoroughly compact pipe bedding with handheld pneumatic compactors.
5. Do not lay pipe until Engineer approves bedding condition.
6. Do not bring pipe into position until preceding length of pipe has been bedded and secured in its final position.

D. Laying Pipe

1. Conform to manufacturer's instructions and requirements of standards and manuals listed below, as applicable:
 - a. Ductile Iron Pipe: ANSI/AWWA C600, ANSI/AWWA C105, AWWA M41.
 - b. Thermoplastic Pipe: ASTM D2321 - Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and other Gravity-Flow Applications; and ASTM D2774 - Standard Practice for Underground Installation of Thermoplastic Pressure Piping.

2. Install pipe accurately to line and grade shown and indicated in the Contract Documents, unless otherwise approved by Engineer. Remove and reinstall pipes that are not installed correctly.
3. Slope piping uniformly between elevations shown.
4. Keep groundwater level in trench at least 24 inches below bottom of pipe before laying pipe. Do not lay pipe in water. Maintain dry trench conditions until jointing and backfilling are complete. Keep clean and protect interiors of pipe, fittings, valves, and appurtenances.
5. Start laying pipe at lowest point and proceed towards higher elevations, unless otherwise approved by Engineer.
6. Place bell and spigot-type pipe so that bells face the direction of laying, unless otherwise approved by Engineer.
7. Excavate around joints in bedding and lay pipe so that pipe barrel bears uniformly on trench bottom.
8. Deflections at joints shall not exceed 75 percent of amount allowed by pipe manufacturer, unless otherwise approved by Engineer.
9. Carefully examine pipe, fittings, valves, and specials for cracks, damage, and other defects while suspended above trench before installation. Immediately remove defective materials from the Site and replace with acceptable products.
10. Inspect interior of all pipe, fittings, valves, and specials and completely remove all dirt, gravel, sand, debris, and other foreign material from pipe interior and joint recesses before pipe and appurtenances are moved into excavation. Bell and spigot-type mating surfaces shall be thoroughly wire brushed, and wiped clean and dry immediately before pipe is laid.
11. Field cut pipe, where required, with machine specially designed for cutting the type of pipe being installed. Make cuts carefully, without damage to pipe, coating or lining, and with smooth end at right angles to axis of pipe. Cut ends on push-on joint type pipe shall be tapered and sharp edges filed off smooth. Do not flame-cut pipe.
12. Do not place blocking under pipe, unless specifically approved by Engineer for special conditions.
13. Touch up protective coatings in manner satisfactory to Engineer prior to backfilling.
14. Notify Engineer in advance of backfilling operations.
15. On steep slopes, take measures acceptable to Engineer to prevent movement of pipe during installation.
16. Thrust Restraint: Where required, provide thrust restraint conforming to Article 3.3 of this Section.
17. Exercise care to avoid flotation when installing pipe in cast-in-place concrete, and in locations with high groundwater.

E. Polyethylene Encasement:

1. Provide polyethylene encasement for ductile iron piping to prevent contact between pipe and surrounding bedding material and backfill.
2. Polyethylene encasement installation shall be in accordance with ANSI/AWWA C105.

F. Jointing Pipe:

1. Ductile Iron Mechanical Joint Pipe:
 - a. Immediately before making joint, wipe clean the socket, plain end, and adjacent areas. Taper cut ends and file off sharp edges to provide smooth surface.
 - b. Lubricate plain ends and gasket with soapy water or manufacturer's recommended pipe lubricant, in accordance with ANSI/AWWAC111, just prior to slipping gasket onto plain end of the joint assembly.
 - c. Place gland on plain end with lip extension toward the plain end, followed by gasket with narrow edge of gasket toward plain end.
 - d. Insert plain end of pipe into socket and press gasket firmly and evenly into gasket recess. Keep joint straight during assembly.
 - e. Push gland toward socket and center gland around pipe with gland lip against gasket.
 - f. Insert bolts and hand-tighten nuts.
 - g. If deflection is required, make deflection after joint assembly and prior to tightening bolts. Alternately tighten bolts approximately 180 degrees apart to seat gasket evenly. Bolt torque shall be as follows:

Pipe Diameter (inches)	Bolt Diameter (inches)	Range of Torque (ft-lbs)
4 to 24	4 to 24	75 to 90

- h. Bolts and nuts, except those of stainless steel, shall be coated with two coats, minimum dry film thickness of eight mils each, of high build solids epoxy or bituminous coating manufactured by Tnemec, or equal.
 - i. Restrained mechanical joints shall be in accordance with Section 40 05 19, Ductile Iron Process Pipe.
2. Ductile Iron Push-On Joint Pipe:
 - a. Prior to assembling joints, thoroughly clean with wire brush the last eight inches of exterior surface of spigot and interior surface of bell, except where joints are lined or coated with a protective lining or coating.
 - b. Wipe clean rubber gaskets and flex gaskets until resilient. Conform to manufacturer's instructions for procedures to ensure gasket resiliency when assembling joints in cold weather.
 - c. Insert gasket into joint recess and smooth out entire circumference of gasket to remove bulges and to prevent interference with proper entry of spigot of entering pipe.
 - d. Immediately prior to joint assembly, apply thin film of pipe manufacturer's recommended lubricant to surface of gasket that will come in contact with entering spigot end of pipe, or apply a thin film of lubricant to outside of spigot of entering pipe.
 - e. For assembly, center spigot in pipe bell and push pipe forward until spigot just makes contact with rubber gasket. After gasket is compressed and before pipe is pushed or pulled in the rest of the way, carefully check gasket for proper position around the full circumference of joint. Final assembly shall be made by forcing spigot end of entering pipe past gasket until spigot makes contact with base of the bell. When more than a reasonable amount of force is required to assemble the joint, remove spigot end of pipe to verify proper positioning of gasket. Do not use gaskets that have been scored or otherwise damaged.
 - f. Maintain an adequate supply of gaskets and joint lubricant at the Site when pipe jointing operations are in progress.
3. Thermoplastic Pipe Joints:

- a. Solvent Cement Welded Joints:
 - 1) Bevel pipe ends and remove all burrs before making joints. Clean pipe and fittings thoroughly. Do not attempt to make solvent cement joints if temperature is below 40 degrees F. Do not make solvent cement welded joints in wet conditions.
 - 2) Use solvent cement supplied or recommended by pipe manufacturer.
 - 3) Apply joint primer and solvent cement and assemble joints in accordance with recommendations and instructions of manufacturer of joint materials and pipe manufacturer.
 - 4) Take appropriate safety precautions when using joint primers and solvent cements. Allow air to circulate freely through pipelines to allow solvent vapors to escape. Slowly admit water when flushing or
 - 5) filling pipelines to prevent compression of gases within pipes.

G. Backfilling:

- 1. Conform to applicable requirements of Division 31.
- 2. Place backfill as Work progresses. Backfill by hand and use power tampers until pipe is covered by at least one foot of backfill.

H. Transitions from One Type of Pipe to Another

- 1. Provide necessary adapters, specials, and connection pieces required when connecting different types and sizes of pipe or connecting pipe made by different manufacturers.

I. Closures:

- 1. Provide closure pieces shown or required to complete the Work.

3.2 TRACER TAPE INSTALLATION

A. Polyethylene Underground Warning Tape for Metallic Pipelines:

- 1. Provide polyethylene tracer tape for buried metallic piping, which includes pipe that is steel, ductile iron, cast iron, concrete, copper, and corrugated metal.
- 2. Provide tracer tape 12 to 18 inches below finished grade, above and parallel to buried pipe.
- 3. For pipelines buried eight feet or greater below finished grade, provide second line of magnetic tracer tape 2.5 feet above crown of buried pipe, aligned along pipe centerline.
- 4. Tape shall be spread flat with message side up before backfilling.

B. Detectable Underground Warning Tape for Non-Metallic Pipelines:

- 1. Provide polyethylene tracer tape with aluminum backing for buried, non-metallic piping, which includes pipe that is PVC, CPVC, polyethylene, HDPE, FRP, ABS, and vitrified clay.
- 2. Provide magnetic tracer tape 12 to 18 inches below finished grade, above and parallel to buried pipe.
- 3. For pipelines buried eight feet or greater below finished grade, provide second line of magnetic tracer tape 2.5 feet above crown of buried pipe, aligned along the pipe centerline.
- 4. Tape shall be spread flat with message side up before backfilling.

3.3 THRUST RESTRAINT

- A. Provide thrust restraint on pressure piping systems where it is required or shown in the Contract Documents.
- B. Thrust restraint shall be accomplished by using restrained pipe joints. Thrust restraints shall be designed for axial thrust exerted by test pressure specified in the Piping Schedule in the Drawings.
- C. Restrained Pipe Joints:
 - 1. Pipe joints shall be restrained by means suitable for the type of pipe being installed.
 - 2. Ductile Iron, Mechanical Joints: Restrain with proprietary restrained joint system as specified in Section 40 23 36, Pipes and Pipe Fittings; lugs and tie rods; or other joint restraint systems approved by Engineer.

3.4 WORK AFFECTING EXISTING PIPING

- A. Location of Existing Underground Facilities:
 - 1. Locations of existing Underground Facilities shown on the Drawings should be considered approximate.
 - 2. Determine the true location of existing Underground Facilities to which connections are to be made, crossed, and that could be disturbed, and determine location of Underground Facilities that could be disturbed during excavation and backfilling operations, or that may be affected by the Work.
- B. Taking Existing Pipelines and Underground Facilities Out of Service:
 - 1.
 - 2. Do not take pipelines or Underground Facilities out of service unless specifically coordinated with Owner's Operations or approved by Engineer.
 - 3. Notify Engineer in writing prior to taking pipeline or Underground Facilities out of service. Shutdown notification shall be provided in advance of the shutdown in accordance with the General Conditions and coordination with Owner's Operations.
- C. Work on Existing Pipelines or Underground Facilities:
 - 1. Cut or tap piping or Underground Facilities as shown or required with machines specifically designed for cutting or tapping pipelines or Underground Facilities, as applicable.
 - 2. Install temporary plugs to prevent entry of mud, dirt, water, and debris into pipe.
 - 3. Provide necessary adapters, sleeves, fittings, pipe, and appurtenances required to complete the Work.
 - 4. Conform to applicable requirements of coordination with the Owner's Operations, Section 01 73 29, Cutting and Patching, and Section 01 73 24, Connections to Existing Facilities.

3.5 FIELD QUALITY CONTROL

- A. General:

1. Test all piping, except as exempted in the Buried Piping Schedule in this Section.
2. When authorities having jurisdiction are to witness tests, notify Engineer and authorities having jurisdiction in writing at least 48 hours in advance of testing.
3. Conduct all tests in presence of Engineer.
4. Remove or protect pipeline-mounted devices that could be damaged by testing.
5. Provide all apparatus and services required for testing, including:
 - a. Test pumps, compressors, hoses, calibrated gages, meters, test containers, valves, fittings, and temporary pumping systems required to maintain Owner's operations.
 - b. Temporary bulkheads, bracing, blocking, and thrust restraints.
6. Provide power if pumping is required.
7. Unless otherwise specified, Owner will provide fluid required for hydrostatic testing. Contractor shall provide means to convey fluid for hydrostatic testing into piping being tested.
8. Repair observed leaks and repair pipe that fails to meet acceptance criteria. Retest after repair.
9. Unless otherwise specified, testing shall include existing piping systems that connect with new piping system. Test existing pipe to nearest valve. Piping not installed by Contractor and that fails the test shall be repaired upon authorization of Owner. Unless otherwise included in the Work, repair of existing piping or Underground Facilities will be paid as extra Work.

B. Test Schedule:

1. Refer to the Buried Piping Schedule in this Section for type of test required and required test pressure.
2. Unless otherwise specified, required test pressures are at lowest elevation of pipeline segment being tested.
3. For piping not listed in Buried Piping Schedule in this Section:
 - a. Hydrostatically test pipe that will convey liquid at a pressure greater than five psig.
4. Test Pressure:
 - a. Use test pressures listed in Buried Piping Schedule in this Section.
 - b. If test pressure is not listed in Buried Piping Schedule, or if test is required for piping not listed in the Buried Piping Schedule, test pressure will be determined by Engineer based on maximum anticipated sustained operating pressure and methods described in applicable ANSI/AWWA manual or standard that applies to the piping system.

C. Hydrostatic Testing:

1. Preparation for Testing
 - a. Follow procedures described in ANSI/AWWA Manual M9. Wetting period is not required for pipe that is not cement mortar lined.
 - b. Prior to testing, ensure that adequate thrust protection is in place and joints are properly installed.
2. Test Procedure:

- a. Fill pipeline slowly to minimize air entrapment and surge pressures. Fill rate shall not exceed one foot of pipe length per second in pipe being tested.
 - b. Expel air from pipe as required. Obtain approval of Engineer prior to tapping pipe for expelling air.
 - c. Examine exposed joints and valves and make repairs to eliminate visible leakage.
 - d. After specified wetting period, add fluid as required to pressurize line to required test pressure. Maintain test pressure for a stabilization period of ten minutes before beginning test.
 - e. Timed test period shall not begin until after pipe has been filled, exposed to required wetting period, air has been expelled, and pressure stabilized.
 - f. Timed Test Period: After stabilization period, maintain test pressure for at least two hours. During timed testing period, add fluid as required to maintain pressure within five psig of required test pressure. For HDPE pipe, after three-hour expansion phase, reduce test pressure by ten psig and do not add liquid. Test pressure shall then remain steady for one hour, indicating no leakage.
 - g. Pump from test container to maintain test pressure. Measure volume of fluid pumped from test container and record on test report. Record pressure at test pump at 15-minute intervals for duration of test.
3. Allowable Leakage Rates: Leakage is defined as the quantity of fluid supplied to pipe segment being tested to maintain pressure within five psi of test pressure during timed test period. Allowable leakage rates for piping are:
- a. Rates based on formula or table in ANSI/AWWA Manual M41:
 - 1) Metal and fiberglass pipe joined with rubber gaskets as sealing members, including the following joint types:
 - a) Bell and spigot and push-on joints.
 - b) Mechanical joints.
 - c) Bolted sleeve type couplings.
 - d) Grooved and shouldered couplings.

3.6 CLEANING

A. Cleaning, General: Clean pipe systems as follows:

1. Thoroughly clean all piping, including flushing with water, dry air, or inert gas as required, in manner approved by Engineer, prior to placing in service.
2. After connecting to equipment, blow out pipe using the equipment.

END OF SECTION 330505

SECTION 330505.09 - PIPE JOINTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

1.2 DESCRIPTION OF WORK

- A. The installation of all piping, fittings, valves, hydrants, etc. in the performance of pipeline construction work shall include the making of one or more types of pipe joints as specified herein.

1.3 QUALITY ASSURANCE

- A. In addition to requirements of these specifications, comply with manufacturer's instructions and recommendations for work.
- B. All castings used for couplings housings, fittings, or valve and specialty bodies shall be date stamped for quality assurance and traceability.
- C. All grooved couplings, fittings, valves, and specialties shall be the products of a single manufacturer. Grooving tools shall be of the same manufacturer as the grooved components.

1.4 SUBMITTALS

- A. Product Data: Submit manufacturer's technical data and application instructions.

PART 2 - PRODUCTS

2.1 PUSH-ON TYPE JOINTS

- A. Push-on type of joints for cast iron and ductile iron pipe shall be made where shown on the plans and as specified herein in strict accordance with the manufacturer's recommendations.
- B. No more than one joint at a time shall be "pushed home". In the event that two (2) or more joints are "pushed home" simultaneously, the Contractor shall remove all pipe which was not pushed home "one at a time" and remove and discard the "used" gaskets and relay the pipe "one at a time."
- C. Rubber gaskets shall be a rubber O-ring type shaped to fit the particular inside configuration of the bells of the pipe being installed and shall produce a leak-free piping system.
- D. Immediately prior to assembly, thoroughly clean all pipe surfaces which the rubber gasket contacts, insert the gasket properly and lubricate the joint surfaces.
- E. All ends shall be beveled and square to the pipe barrel and shall be kept in a straight and square alignment to the receiving bell during assembly.

- F. No weight will be allowed for nor payment made for the gasket or lubricant used, but the cost thereof shall be included in the unit price bid for compression joint cast iron and/or ductile iron pipe and fittings.
- G. All "job" cut pipe ends shall be ground, filed or otherwise properly worked on so as to be both square to the pipe barrel and beveled similar to "factory" finished pipe ends. There shall be no "burrs" on any part of the cut pipe end.

2.2 FLANGED JOINTS FOR CAST IRON/DUCTILE IRON PIPE AND FITTINGS

- A. All flanged joints shall be thoroughly bolted with through stud or tap bolts of required size. Full face type rubber gaskets of an approved quality equal in all respects to "Rainbow" gaskets one-eighth (1/8) inch thick as manufactured by the U.S. Rubber Company shall be used in all flanged joints. All bolt heads and nuts shall conform in dimensions to the American Standard heavy series and nuts shall be hexagonal cold pressed with well fitting threads. Bolts and nuts shall be cadmium plated by an approved process with a plate thickness of 0.0003 to 0.0005 inches. In lieu of cadmium plating, galvanizing will be acceptable. All studs shall be made from silicon bronze ASTM B 124 with bronze nuts where used in contact with any liquid or buried underground or as called for on the contract drawings.
- B. All nuts and bolts that come into contact with water shall be painted with two (2) heavy coats of Inertol No. 49 thick or approved equal, made for bolts, studs, nuts or gaskets used for flanged joints, and the cost thereof shall be included in the unit price bid for flanged cast/ductile iron pipe and flanged cast/ductile iron fittings.

2.3 MECHANICAL JOINTS

- A. All mechanical joints shall be thoroughly bolted in accordance with the manufacturer's recommendations with cadmium plated tee head bolts and nuts of high strength, heat treated cast iron or other approved materials having a minimum yield strength of forty- five thousand (45,000) pounds per square inch and an ultimate tensile strength of seventy thousand (70,000) pounds per square inch. Gaskets for sludge, gas, waste lines, etc., shall be plain rubber gaskets coated with Thiccol or ASTM D 2000, Type SA-710, or equal. Gaskets for water service shall be plain rubber gaskets made of first grade plantation rubberin accordance with ANSI A21.11. Glands shall be of high strength cast/ductile iron.
- B. Where connections are made between wrought iron pipe and mechanical joints, an approved type of transition gasket and fitting shall be used in the mechanical joint in accordance with the manufacturer's standards and recommendations.
- C. All "job" cut pipe ends shall be ground, filed or otherwise properly worked on so as to be both square to the pipe barrel and beveled similar to "factory" finished pipe ends. There shall be no "burrs" on any part of the cut pipe end.
- D. Joint bolts shall be tightened by the use of approved wrenches and to a tension recommended by the pipe manufacturer. Overstressing of bolts to compensate for poor installation practice shall not be permitted.
- E. If sections of pipeline are "preassembled", at a location other than the intended final resting location of the piping, so as to include a fitting or line valve, the Contractor shall handle such "preassembled" sections so as to avoid deflections greater than allowed in published data normally provided by the respective pipe manufacturer. Such sections shall be limited in length to include no more than a standard length of pipe plus one (1) fitting and shall contain no more than two (2)

preassembled joints. Any excessively deflected "preassembled pipe" shall be disassembled, the gaskets shall be discarded, and the preassembly (if it be repeated) all at the Contractor's risk and expense.

- F. Where joints are underground, bolts and nuts shall be stainless steel Type 316.
- G. Where shown on the drawings, or ordered, mechanical joints shall be provided with approved harnesses to effect tied joints.
- H. No special payment will be made for lock type joints, glands, bolts, nuts or gaskets used for mechanical joints, but the cost thereof shall be included in the unit price bid for mechanical joint cast/ductile iron pipe and mechanical joint cast/ductile iron fittings. Payment on a tonnage basis will be based on the body weight of the pipe or fittings only and will not show additional weight of accessories.
- I. Approved harnesses to effect tied joints will be paid for as a part of their respective pipeline construction.

2.4 BALL AND SOCKET JOINTS

- A. Ball and socket joints shall be made where shown on the drawings and shall conform to AWWA C111 and shall be subject to the approval of the Engineer.
- B. Ball and socket joints shall be as manufactured by Clow Corporation, American Cast Iron Pipe Company or equal.

2.5 GROOVED-END JOINT COUPLINGS

- A. Grooved-end joint couplings for ductile iron piping shall be used where indicated on the drawings. Grooved and joint couplings shall be watertight, and designed for the working pressures specified for the piping system with which they are to be used. Couplings shall be self-centering and shall engage and lock in place the grooved pipe and pipe fitting ends, in a positive couple. Where grooved-end joint couplings are shown on the drawings, pipe grooves shall be located such as to provide a flexible-type joint which provides for linear and angular movement. Coupling housing clamps shall be fabricated in two or more sections of ductile iron castings, conforming to the requirements of ASTM A 536, Grade 65-45-12. Coupling gaskets shall be molded synthetic rubber, FlushSeal®, conforming to ASTM D 2000, Grade to suit the intended service. Bolts shall be oval neck, track head type, with hexagonal heavy nuts conforming to ASTM A449 and A 183. Grooved, hinged flange adapters, with gaskets, shall be furnished for making valve or flanged connections, and shall be constructed of the same materials as used for the couplings. Basis of Design: Victaulic Style 31 (coupling) and Style 341 (flange adapter).
 - 1. For direct connection between IPS / steel pipe and AWWA / ductile iron pipe, Victaulic Style 307 transition coupling.
- B. Pipe grooving shall be done by the manufacturer and in accordance with the pipe coupling manufacturer's specifications.
- C. Field grooving of pipe shall not be permitted, except for occasional field make-up pieces when permitted by the Engineer.
- D. Grooved joints shall be installed in accordance with the manufacturer's latest published instructions. The gasket style and elastomeric material (grade) shall be verified as suitable for the intended service. Gaskets shall be molded and produced by the grooved coupling manufacturer.

Grooved ends shall be clean and free from indentations and projections in the area from pipe end to groove.

1. Grooved coupling manufacturer's factory trained field representative shall provide on-site training for contractor's field personnel in the installation of grooved piping products.
2. Factory trained representative shall periodically visit the jobsite to ensure best practices in grooved product installation are being followed. Contractor shall remove and replace any improperly installed products.

E. Grooved-end joint couplings shall be Victaulic, Dresser or engineer approved equal.

2.6 SPLIT-SLEEVE COUPLING JOINTS

A. Couplings are to be bolted, split-sleeve type and consist of one or more housing segment(s), gasket assembly, and required bolts and nuts. Coupling shall be manufactured from ASTM A36 for carbon steel couplings or ASTM A240 Type 316/316L for stainless steel couplings.

1. The coupling shall be of the split-sleeve type with a single or double arch cross section which closes around pipe ends that are smooth for expansion or contraction requirements or pipe ends.
2. The sealing members are comprised of single gasket or two O-Rings and an elastomer-sealing pad bonded to the sealing plate. Internal pressure is not required to effect the seal.
3. Carbon steel studs shall be zinc plated and conform to ASTM A193 Grade B7. Carbon steel nuts shall be zinc plated and conform to ASTM A194 Grade 2H. Stainless steel studs shall conform to ASTM F593 Class 2 Grade B8M. Stainless steel nuts shall conform to ASTM F594 Grade 8M, 316.

B. Couplings shall be split-sleeve as manufactured by Victaulic Company or approved equal.

2.7 BOLTLESS RESTRAINED JOINT

A. Boltless restrained joints shall be used where called for on the drawings or as directed by the Engineer to provide restraint against external forces or against separation due to internal pressure.

B. Types of boltless restrained joints acceptable are "Super-Lock" by Clow Corporation, "Flex-Ring" by American Cast Iron Pipe Company, "TR-Flex" by United States Pipe and Foundry Company or equal.

PART 3 - INSTALLATION (NOT USED)

END OF SECTION 330505.09

SECTION 330519 - DUCTILE IRON PIPE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

1.2 DESCRIPTION OF WORK

- A. The Contractor shall furnish all the materials for and shall properly place at the locations shown on the drawings or as directed, all ductile iron pipe of the sizes specified, shown or required for the proper completion of the work included under this contract.

1.3 QUALITY ASSURANCE

- A. In addition to requirements of these specifications, comply with manufacturer's instructions and recommendations for work.

1.4 SUBMITTALS

- A. Product Data: Submit manufacturer's technical data and application instructions.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. All ductile iron pipe shall conform to AWWA C151 with the ends being designed for one of the type joints as specified herein.
- B. To assure that the iron is suitable for satisfactory drilling and cutting, the chemical constituents shall meet the physical property recommendations of ASTM A 536.
- C. The minimum wall thickness of the pipe barrel shall be that indicated in ANSI A21.50 (AWWA C150) for laying condition "2", 150 psi internal working pressure and a surge pressure of 100 psi and 5 ft. depth of cover unless otherwise indicated on the drawings. ANSI A21.50 (AWWA C150) CLASS 52 shall be the minimum thickness class for ductile iron pipe furnished under this specification unless otherwise shown on the drawings.

2.2 COATING AND LINING

- A. The outside surface of all ductile iron pipe shall be shop coated with either a coal tar or asphalt base bituminous material. If this coating material is found to be damaged prior to the pipe trench being backfilled, the Contractor shall provide and apply additional material of that required to repair the damages. The Contractor shall have sufficient coating material available at the job site prior to laying the pipe.
- B. The interior of the pipe shall be lined with cement mortar and seal coated in complete conformance with ANSI A21.4 (AWWA C104).

2.3 JOINTS

- A. Mechanical Joints and Push-on Joints including their respective appurtenances shall conform to ANSI A21.11 (AWWA C111).
- B. Flanged Joints shall conform to AWWA C110 or ANSI A21.10. Flanged joints shall not be installed underground except within structures as indicated on plans or directed by the Engineer.
- C. Appurtenances used to make flanged joints shall include: one-eighth (1/8) inch thick rubber gaskets, bolts having American Standard Heavy Unfinished Hexagonal Head and Nut dimensions in conformance with ANSI B18.1, and material for bolts and nuts shall conform to ASTM A 575 or A 576.
- D. Ball and socket joints (river crossing) shall be restrained, boltless and capable of deflecting up to 15 degrees and shall be installed in accordance with the manufacturer's recommendations.

2.4 POLYETHYLENE ENCASEMENT

- A. The ductile iron pipe, fittings and appurtenances buried underground, shall be encased with 8 mil polyethylene film conforming to AWWA C105, unless noted otherwise.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. All trenches, when pipe laying is in progress, shall be kept dry and all pipes and specials shall be laid accurately to the required lines and grades and shall be uniformly supported along their entire lengths. The bottom of the excavation shall be properly trimmed, with holes at each joint to receive the bell and to permit the properly cementing the joints.
- B. Pipe shall be fully entered and shall abut against adjacent pipe and in such a manner that there will be no unevenness along the inverts.
- C. When pipes enter or pass through concrete walls, manholes, sewers or other structures, holes shall be provided and the pipes properly cemented in place so as to form a watertight joint.

END OF SECTION 330519

SECTION 330531.17 – PVC PIPE (ASTM D2241)

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

1.2 DESCRIPTION OF WORK

- A. The Contractor shall furnish all the materials for and shall properly place at the locations shown on the drawings or as directed, all PVC pipe of the sizes specified, shown or required for the proper completion of the work included under this contract.

1.3 QUALITY ASSURANCE

- A. In addition to requirements of these specifications, comply with manufacturer's instructions and recommendations for work.

1.4 SUBMITTALS

- A. Product Data: Submit manufacturer's technical data and application instructions.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. All PVC pipe used, as covered under this section, shall conform to ASTM D2241, with end being designated for one of the type joints as specified herein.
- B. The minimum class for PVC pipe under this Item shall be SDR 26 (PR 160 psi).

2.2 JOINTS

- A. Polyvinyl chloride pipe joints shall be integral bell push-on type meeting the requirements of ASTM D 3139.
- B. All fittings shall be Mechanical Joint C153 DIP. All Mechanical Joints shall be restrained with mechanical devices except for tees in the main no closer than 40 feet from the end of a run. Pipe stubs or nipples 30 inches or less (i.e. between Hydrant Tees and Watch Valves or between Watch Valves and Hydrants) shall be Cast Iron or Ductile Iron with restraining anchor glands.
- C. Nuts and bolts used on buried pressure pipe and fittings in contact with earth shall be of stainless steel Type 316.
- D. Nuts and bolts which will be in contact with sewage shall be stainless steel, Type 316.

- E. All other nuts and bolts shall be low carbon steel in conformance with the chemical and mechanical requirements of ASTM A307, Grade B. Higher strength bolts shall be acceptable.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. All trenches, when pipe laying is in progress, shall be kept dry and all pipes and specials shall be laid accurately to the required lines and grades and shall be uniformly supported along their entire lengths. The bottom of the excavation shall be properly trimmed, with holes at each joint to receive the bell and to permit the properly cementing the joints.
- B. Pipe shall be fully entered and shall abut against adjacent pipe and in such a manner that there will be no unevenness along the inverts.
- C. When pipes enter or pass through concrete walls, manholes, sewers or other structures, holes shall be provided and the pipes properly cemented in place so as to form a watertight joint.

END OF SECTION 330531.17

SECTION 330531.19 - PVC PIPE (ASTM D 1785)

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

1.2 DESCRIPTION OF WORK

- A. The Contractor shall furnish and install all polyvinyl chloride (PVC) pipe as specified herein, shown on the Drawings or as directed by the Engineer.

1.3 QUALITY ASSURANCE

- A. In addition to requirements of these specifications, comply with manufacturer's instructions and recommendations for work.

1.4 SUBMITTALS

- A. Product Data: Submit manufacturer's technical data and application instructions.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. All PVC pipe used, as covered under this section, shall conform to ASTM D 1785, with end being designated for one of the type joints as specified herein. PVC compounds shall conform to ASTM D 1784.
- B. PVC pipe under this section shall be Schedule 40, 80 or 120 as indicated on the drawings.
- C. Materials of construction, including joints and fittings, shall be suitable for exposure to raw sewage.

2.2 JOINTS AND FITTINGS

- A. Solvent cemented joints for pipe and fittings shall conform to ASTM D 2855.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. All trenches, when pipe laying is in progress, shall be kept dry and all pipes and specials shall be laid accurately to the required lines and grades and shall be uniformly supported along their entire lengths. The bottom of the excavation shall be properly trimmed, with holes at each joint to receive the bell and to permit the properly cementing the joints.
- B. Pipe shall be fully entered and shall abut against adjacent pipe and in such a manner that there will be no unevenness along the inverts.
- C. When pipes enter or pass through concrete walls, manholes, sewers or other structures, holes shall be provided and the pipes properly cemented in place so as to form a watertight joint.

END OF SECTION 330531.19

SECTION 330533.23 - HIGH DENSITY POLYETHYLENE (HDPE) PIPE AND FITTINGS

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

- A. The work covered by this Section includes but is not limited to Ductile Iron Pipe Size (DIPS) high-density polyethylene pipe intended for the transportation of potable water.
- B. It is the intent of this Contract that the final installation be complete in all respects and the Contractor shall be responsible for minor or specific details; coordination with trades, equipment manufacturing, installation and manufacturers start-up representatives; and any necessary special construction not specifically included in the Drawings or Specifications.

1.2 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General Supplementary Conditions and Division-1 Specifications sections apply to work of this section.

1.3 QUALITY ASSURANCE

- A. The named equipment in addition to the detailed specifications, establishes the minimum acceptable standards of material and workmanship. In addition to requirements of these Specifications, all work performed shall be in accordance with approved trade practices and manufacturers recommendations. All equipment shall perform as specified and accessories shall be provided as required for satisfactory operation.
- B. The Contractor shall coordinate and verify that the material furnished meets the Specification, intentions and design criteria prior to equipment submittals and shipment from the manufacturer to the project site.
- C. Material References:

<u>Reference</u>	<u>Title</u>
1. AWWA C906	Polyethylene (PE) pressure Pipe & Fittings 4-inch through 63-inch for water dist.
2. ASTM D3261	Butt Heat Fusion PE Fittings for PE Pipe and Tubing
3. ASTM D3350	Standard Specification for PE Pipe & Fittings Materials
4. ASTM D1238	Standard Test Method for Flow Rates of Thermoplastics by Extrusion Plastometer
5. ASTM D1505	Density of Plastics
6. ASTM D2837	Hydrostatic Design Basis
7. NSF Std. #14	Plastic Piping Components & Y Related Materials
8. ASTM F714	Standard Specification for Polyethylene (PE) Plastic Pipe (SDR-PR) Based on Outside Diameter
9. ASTM F905	Standard Practice for Qualification of Polyethylene Saddle-Fused Joints
10. ASTM F 1055	Standard Specification for Electrofusion Type Polyethylene Fittings for Outside Diameter Controlled Polyethylene Pipe and Tubing

1.4 SUBMITTALS

- A. Product Data: Submit manufacturer's technical data and application instructions. Include the following:
 - 1. Melt Flow Index ASTM D1238
 - 2. Density ASTM D1505
- B. Shop Drawings: The Contractor shall submit complete shop drawings of all materials furnished for this project.

PART 2 - PRODUCT

2.1 GENERAL

- A. Manufacturer
 - 1. All HDPE pipe and fittings shall be from a single manufacturer, who is fully experienced, reputable and qualified in the manufacture of the HDPE Pipe to be furnished. The pipe shall be designed, constructed and installed in accordance with the best practices and methods and shall comply with these Specifications.
 - 2. Qualified manufacturers shall be: PLEXCO Division of Chevron Chemical Company, DRISCOPIPE as manufactured by Phillips Products Co., Inc. SCLAIRPIPE as manufactured by Dupont of Canada, or equal as approved by the Engineer.
- B. Quality Control
 - 1. Production staff shall check each length of pipe produced for the items listed below. The results of all measurements shall be recorded on production sheets, which become part of the manufacturer's permanent records.
 - a. Pipe in process shall be checked visually, inside and out for cosmetic defects (grooves, pits, hollows, etc.)
 - b. Pipe outside diameter shall be measured using a suitable periphery tape to ensure conformance with ASTM F714 or ASTM D3035, whichever is applicable.
 - c. Pipe wall thickness shall be measured at 12 equally spaced locations around the circumference at both ends of the pipe to ensure conformance with ASTM F714 or ASSTM D3035, whichever is applicable.
 - d. Pipe length shall be measured.
 - e. Pipe marking shall be examined and checked for accuracy.
 - f. Pipe ends shall be checked to ensure they are cut square and clean.
 - g. Subject inside surface to a "reverse bend test" to ensure the pipe is free of oxidation (brittleness).
- C. Testing
 - 1. The polyethylene pipe manufacturer shall provide certification that stress regression testing has been performed on the specific polyethylene resin being utilized in the manufacture of this product. This stress regression testing shall have been done in accordance with ASTM D2837 and the manufacturer shall provide a product supplying a minimum Hydrostatic Design Basis (HDB) of 1,600 psi as determined in accordance with ASTM D2837.
- D. Compatibility
 - 1. Contractor is responsible for compatibility between pipe materials, fittings and appurtenances.

2.2 MATERIALS FOR PIPE SIZES 4-INCH DIAMETER AND LARGER

- A. Materials used for the manufacture of polyethylene pipe and fittings shall be made from a PE 3408 high density polyethylene resin compound meeting cell classification 345434C per ASTM D3350; and meeting Type III, Class C, Category 5, Grade P34 per ASTM D1238.
- B. High Density Polyethylene (HDPE) pipe shall comply with AWWA Specifications C906.
- C. If rework compounds are required, only those generated in the Manufacturer's own plant from resin compounds of the same class and type from the same raw material supplier shall be used.
- D. Dimensions and workmanship shall be as specified by ASTM F714. HDPE fittings and transitions shall meet ASTM D3261. HDPE pipe shall have a minimum density of 9.955 grams per cubic centimeter. All HDPE pipe and fittings shall have a Hydrostatic Design Basis (HDB) of 1,600 psi.
- E. HDPE pipe and accessories shall be 200 psi at 73.4°F meeting the requirements of Dimension Ratio (DR) 11 as MINIMUM STRENGTH.
- F. HDPE pipe used for waterlines shall be black with exterior blue striping.
- G. The pipe Manufacturer must certify compliance with the above requirements.

2.3 FITTINGS

- A. All molded fittings and fabricated fittings shall be fully pressure rated to match the pipe SDR pressure rating to which they are made. All fittings shall be molded or fabricated by the manufacturer. No Contractor fabricated fittings shall be used unless approved by the Engineer.
- B. The manufacturer of the HDPE pipe shall supply all HDPE fittings and accessories as well as any adapters and/or specials required to perform the work as shown on the Drawings and specified herein.
- C. All fittings shall be installed using butt-fused fittings, thermo-fused fittings/couplings, or flanged adapters and must be approved by the Engineer. No size on size wet taps shall be permitted.
- D. Electrofusion Fittings shall be made of HDPE material with a minimum material designation code of PE 3608 and with a minimum Cell Classification as noted in 3.2.A. Electrofusion Fittings shall comply with ASTM F1055. Fittings shall have a pressure rating equal to the pipe unless otherwise specified on the plans. All electrofusion fittings shall be suitable for use as pressure conduits, and have nominal burst values of four times the Working Pressure Rating (WPR) of the fitting. Markings shall be according to ASTM F 1055.
- E. Service connections shall be electrofusion saddles with a brass or stainless steel threaded outlet. The size of the outlet shall be as shown on the plans.
- F. All transition from HDPE pipe to PVC shall be made per the approval of the Engineer and per the HDPE pipe manufacturer's recommendations and specifications. A molded flange connector adapter within a back-up ring assembly shall be used for pipe type transitions. Back up rings shall be stainless steel.
 - 1. A harness restraint or concrete anchor is required at all mechanical couplings to prevent pullout.
 - 2. No solid sleeves shall be allowed between such material transitions.

3. Fittings and transitions shall be as manufactured by Phillips Driscopipe, Inc., 1000 Series Pressure Pipe, Chevron Chemical Company Plexco/Spiralite pipe, or equal.
4. The pipe supplier must certify compliance with the above requirements.

2.4 PIPE IDENTIFICATION

- A. The following shall be continuously indent printed on the pipe or spaced at intervals not exceeding 5 feet:
 1. Name and/or trademark of the pipe manufacturer.
 2. Nominal pipe size.
 3. Dimension ratio.
 4. The letters PE followed by the polyethylene grade in accordance with ASTM D1248 followed by the hydrostatic design basis in 160's of psi, e.g., PE 3408.
 5. Manufacturing standard reference, e.g., ASTM F714 or D-3035, as required.
 6. A production code from which the date and place of manufacture can be determined.
 7. Color identification, either stripped by co-extruding longitudinal identifiable color markings or shall be solid in color and as follows:
 - a. BLUE – Potable Water

PART 3 - EXECUTION

3.1 JOINTING METHOD

- A. The pipe shall be joined with butt, heat fusion joints as outlined in ASTM D2657. All joints shall be made in strict compliance with the manufacturer's recommendations. A factory qualified joining technician as designated by pipe manufacturer or experienced, trained technician shall perform all heat fusion joints in the present of the inspector.
- B. Lengths of pipe shall be assembled into suitable installation lengths by the butt-fusion process. All pipe so joined shall be made from the same class and type of raw material made by the same raw material supplier. Pipe shall be furnished in standard laying lengths not to exceed 50 feet and no shorter than 20 feet.
- C. On days butt fusions are to be made, the first fusion shall be a trial fusion in the presence of an inspector. The following shall apply:
 1. Heating plates shall be inspected for cuts and scrapes. The plate temperature shall be measured at various locations to ensure proper heating/melting per manufacturer's recommendations and approval by the inspector.
 2. The fusion or test section shall be cut out after cooling completely for inspection.
 3. The test section shall be 12' or 30 times (minimum) the wall thickness in length and 1" or 1.5 times the wall thickness in width (minimum).
 4. The joint shall be visually inspected as to continuity of "beads" from the melted material, and for assurance of "cold joint" prevention (i.e., joint shall have visible molded material between walls of pipe). Joint spacing between the walls of the two ends shall be a minimum of 1/16" to a maximum of 3/16".
- D. Saddle fusion: Saddle fusion shall be done in accordance with ASTM F 2620 or TR-41 or the fitting manufacturer's recommendations and PPI TR-41. Saddle fusion joints shall be made by qualified fusion technicians. Qualification of the fusion technician shall be demonstrated by evidence of fusion training within the past year on the equipment to be utilized on this project.

- E. The polyethylene flange adapters at pipe material transitions shall be backed up by stainless steel flanges conforming to ANSI B16.1 and shaped as necessary to suit the outside dimensions of the pipe. The flange adapter assemblies shall be connected with corrosion resisting bolts and nuts of Type 316 Stainless Steel as specified in ASTM A726 and ASTM A307. All bolts shall be tightened to the manufacturer's specified torques. Bolts shall be tightened alternately and evenly. After installation apply a bitumastic coating to bolts and nuts.

3.2 INSTALLATION

- A. High Density Polyethylene (HDPE) Pipe shall be installed in accordance with the manufacturer recommendations. A factory qualified joining technician as designated by the pipe manufacturer shall perform all heat fusion joints.
- B. HDPE shall be installed by Directional Bore Method.
- C. Care shall be taken in loading, transporting and unloading to prevent injury to pipe. Pipe or fitting shall not be dropped. All pipe or fitting shall be examined before installation, and no piece shall be installed which is found to be defective. Any damage to the pipe shall be repaired as directed by the Engineer. If any defective pipe is discovered after it has been installed, it shall be removed and replaced with a sound pipe in a satisfactory manner by the contractor, at his own expense.
- D. Under no circumstances shall the pipe or accessories be dropped into the trench or forced through a directional bore upon "pull-back".
- E. Care shall be taken during transportation of the pipe such that it will not be cut, kinked or otherwise damaged.
- F. Ropes, fabric or rubber protected slings and straps shall be used when handling pipes. Chains, cables or hooks inserted into the pipe ends shall not be used. Two slings spread apart shall be used for lifting each length of pipe.
- G. Pipes shall be stored on level ground, preferably turf or sand, free of sharp objects, which could damage the pipe. Stacking of the polyethylene pipe shall be limited to a height that will not cause excessive deformation of the bottom layers of pipes under anticipated temperature conditions. Where necessary due to ground conditions, the pipe shall be stored on wooden sleepers, spaced suitably and of such width as not to allow deformation of the pipe at the point of contact with the sleeper or between supports.
- H. Pipe shall be stored on clean level ground to prevent undue scratching or gouging. The handling of the pipe shall be in such a manner that the pipe is not damaged by dragging it over sharp and cutting objects. The maximum allowable depth of cuts, scratches or gouges on the exterior of the pipe is 5 percent of wall thickness. The interior pipe surface shall be free of cuts, gouges or scratches.
- I. Pipe shall be laid to lines and grade shown on the Drawings with bedding and backfill as shown on the Drawings.
- J. When laying is not in progress, including lunchtime, the open ends of the pipe shall be closed by fabricated plugs, or by other approved means.

- K. Sections of pipe with cuts, scratches or gouges exceeding 5 percent of the pipe wall thickness shall be removed completely and the ends of the pipeline rejoined.
- L. The pipe shall be joined by the method of thermal butt fusion, as outlined in PART 3 – Execution, Section 3.1 Joining Method. All joints shall be made in strict compliance with the manufacturer's recommendations.
- M. Mechanical connections of the polyethylene pipe to auxiliary equipment such as valves, pumps and tanks shall be through flanged connections which shall consist of the following.
 - 1. A polyethylene flange shall be thermally butt-fused to the stub end of the pipe.
 - 2. A 316 stainless steel back-up ring shall mate with a 316 stainless steel flange.
 - 3. 316 stainless steel bolts and nuts shall be used.
- N. Flange connections shall be provided with a full-face neoprene gasket.
- O. All HDPE pipe must be at the temperature of the surrounding soil at the time of backfilling and compactions.
- P. If a defective pipe is discovered after it has been installed, it shall be removed and replaced with a sound pipe in a satisfactory manner at no additional cost to the Owner. All pipe and fittings shall be thoroughly cleaned before installation, shall be kept clean until they are used in the work and when laid, shall conform to the lines and grades required.

3.3 RECORD KEEPING AND RECORD DRAWINGS

- A. The Contractor shall maintain a daily record of the drilling operations and a guidance system log with a copy given to Engineer at completion of boring.
- B. The MGS data shall be recorded during the actual crossing operation. The Contractor shall furnish as-built plan and profile drawing based on these recordings showing the actual location horizontally and vertically of the installation, and all utility facilities found during the installation. The MGS data shall be certified accurate by the Contractor to the capability of the MGS System.
- C. Record drawings shall be completed and reviewed by the Engineer and prepared at the Contractor's expense. The as-built drawings shall be certified by the Contractor for accuracy.

3.4 CLEANING

- A. At the conclusion of the work, thoroughly clean all of the new pipe lines to remove all dirt, stones, pieces of wood or other material which may have entered during the construction period by forcing a cleaning swab through all mains 6" or greater. Flushing velocities shall be a minimum of 2.5 feet per second. All flushing shall be coordinated with the inspector. Debris cleaned from the lines shall be removed from the job site.

3.5 PIPE TESTING

- A. Following the successful pullback of the pipe, the Contractor shall hydro-test pipe from end to end.

END OF SECTION 330533.23

SECTION 331219.10 - POST HYDRANTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

1.2 DESCRIPTION OF WORK

- A. The Contractor shall furnish all the materials for and shall properly set in place, all post hydrants, gravel drain pits, copper pipe and anchors, together with wrenches and keys for the proper completion of the work included under this contract.
- B. In general, this work includes the connecting up to the water main, installing gravel drain pit, necessary copper pipe and post hydrant as herein specified plus concrete anchor or other thrust restraint as directed by the Engineer.
- C. It is the intent of this contract that the final installation shall be complete in all respects and the Contractor shall be responsible for minor details and any necessary special construction not specifically included in the Drawings or Specifications.

1.3 QUALITY ASSURANCE

- A. In addition to requirements of these specifications, comply with manufacturer's instructions and recommendations for work.

1.4 WORKMANSHIP

- A. All work shall be installed in strict accordance with the requirements, codes and ordinances of the Owner and shall meet the inspection of same. Workmanship shall be first class in every respect and all work shall be carried out by persons who are thoroughly experienced in this line of work.

1.5 SUBMITTALS

- A. The Contractor shall submit detail drawings, drawn to scale, catalog data, three (3) copies of head loss charts and cuts of all equipment he proposes to furnish.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Post hydrants shall have a bury depth of not less than 4'-0".
- B. Post hydrants shall be of the anti-freezing type with operating valves buried below the frost line which are easily removable without digging up the hydrant.
- C. The post hydrant casing shall be bronze or aluminum.

- D. The post hydrant shall be supplied with a wheel handle, T-handle or cast steel lever handle. No pedal-operated or self-closing hydrant will be permitted.
- E. Outlet and inlet connections shall be of the same size as the post hydrant supplied.
- F. Each post hydrant shall be stenciled with the words "Unsafe Water - Do Not Drink". The size of the stenciled letters shall be 1 inch. Stencil on the hydrants is to be on the nozzle section.
- G. Post hydrants connected to potable water service mains shall be of the anti-freezing, non-pollutable type.
- H. The hydrant shall be supplied with a vacuum breaker on the outlet.

2.2 MANUFACTURERS

- A. Post hydrants connected to potable water sources shall be one inch (1") anti-freezing, non-pollutable series, M-100 as manufactured by Murdock, Inc. or approved equal.

2.3 ACCESSORIES

- A. Corporation and Curb Stops
 1. Ford Meter Box Company, Inc. (The); Pipe Products Div.
 2. Master Meter, Inc.
 3. Mueller Co.; Water Products Div.
 4. Red Head Manufacturing & Supply.
- B. Service-Saddle Assemblies: Comply with AWWA C800. Include saddle and valve compatible with tapping machine.
 1. Service Saddle: Copper alloy with seal and AWWA C800, threaded outlet for corporation valve.
 2. Corporation Valve: Bronze body and ground-key plug, with AWWA C800, threaded inlet and outlet matching service piping material.
 3. Retain subparagraph below if utility company requires multiple connections.
 4. Manifold: Copper fitting with two to four inlets as required, with ends matching corporation valves and outlet matching service piping material.
- C. Curb Valves: Comply with AWWA C800. Include bronze body, ground-key plug or ball, and wide tee head, with inlet and outlet matching service piping material.
- D. Service Boxes for Curb Valves: Similar to AWWA M44 requirements for cast-iron valve boxes. Include cast-iron telescoping top section of length required for depth of burial of valve, plug with lettering "WATER," and bottom section with base that fits over curb valve and with a barrel approximately 3 inches in diameter.
- E. Shutoff Rods: Steel, tee-handle with one pointed end, stem of length to operate deepest buried valve, and slotted end matching curb valve.

PART 3 - EXECUTION

3.1 INSTALLING HYDRANTS

- A. Post hydrants shall be installed where shown on the plans or as directed by the Engineer. The completed installation shall be completely accessible and shall be such that the possibility of damage from vehicles or injury to pedestrians will be minimized.

- B. All post hydrants shall be installed plumb. Post hydrants shall be set according to the contract drawings.
- C. Each post hydrant shall be connected to the main with a branch connection of the same size as the post hydrant inlet.
- D. A drainage pit shall be excavated at each post hydrant and filled with coarse gravel or crushed stone, mixed with coarse sand, compacted in place under and around the elbow of the post hydrant as illustrated on the drawings. No drainage pit shall be connected to a sewer.

3.2 CLEANING AND PAINTING

- A. The post hydrant shall be painted in accordance with Section 099700.
- B. Post hydrants shall be painted dark blue.

3.3 HYDROSTATIC TEST

- A. Each post hydrant shall be tested at the shop by hydraulic pressure.
- B. The criteria for testing the approved post hydrants shall conform to the requirements of the Owner with regards to pressures and length of tests.
- C. Any post hydrant found defective shall be rejected.

3.4 OPERATION AND MAINTENANCE MANUALS

- A. Prior to or with the delivery of equipment, the manufacturer shall provide copies of an operation and maintenance manual including storage, installation, start-up, operating and maintenance instructions, and a complete parts list and recommended spare parts list. The O & M manuals shall be in compliance with the General Requirements.

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END OF SECTION 331219.10

SECTION 331413 - WATERLINE CONSTRUCTION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

1.2 DESCRIPTION OF WORK

- A. This work shall consist of the construction of a potable water pipeline in accordance with these specifications and in reasonably close conformity to the lines and grades indicated on the plans or as established by the Engineer. This work shall include excavating for pipe, fittings, valves, thrust blocks and other appurtenances, clearing and grubbing and the removal of all materials necessary for placing the pipe, except removals listed separately; furnishing and placing granular or concrete bedding and granular backfill as required, constructing and subsequently removing all necessary cofferdams, cribs, and sheeting, pumping and dewatering, making all pipe joints as required, installing all necessary pipe, joining to existing and proposed appurtenances as required, performing leakage tests as specified, disinfecting and restoration of disturbed facilities and surfaces. Arrangements for and the performance of the adequate and satisfactory disposal of all test and disinfection waters shall be the Contractor's responsibility. The Contractor shall chlorinate the water main as often as necessary to achieve an approved potable water test.

1.3 QUALITY ASSURANCE

- A. In addition to requirements of these specifications, comply with manufacturer's instructions and recommendations for work.

1.4 SUBMITTALS

- A. Product Data: Submit manufacturer's technical data and application instructions.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Pipe, fittings, specials, valves, joint materials, hydrants, thrust blocks, backfill and other appurtenances shall be the size and kind specified in the proposal and shown on the plans.

PART 3 - EXECUTION

3.1 LAYING PIPE

- A. The Contractor shall furnish all of the proper tools and equipment required for the safe, proper handling and laying of all pipe, fittings, and specials that are to be installed in this work. All storage, handling, laying, and backfill methods shall be performed so as to avoid damaging either the

interior or the exterior surfaces of all pipe fittings, specials, joint materials, or other appurtenances, and any such damage shall be remedied at the Contractor's expense.

- B. Before any pipe is lowered into the trench, it shall be inspected for damage, and any unsatisfactory lengths shall be rejected. Cast metal pipe and fittings shall be inspected for cracks by ringing with a light hammer while suspended. The interior and exterior of each pipe length used shall be cleaned as necessary to remove all dirt or other foreign material before it is inspected. The interior of the pipe shall be kept clean until the work is accepted.
- C. No pipe shall be laid in water, mud or when trench conditions or weather is unsuitable for such work.
- D. If mud, surface water, leaves and/or other debris have been permitted to enter the strung-out pipe, the inside shall be cleaned with a strong hypochlorite solution after all such foreign materials are completely cleaned from the pipe and before the pipe is lowered into the trench.
- E. Pipe shall not be pushed off the bank nor shall it be permitted to fall into the trench. Each type of pipe, fitting, special or other appurtenances shall be handled in strict accordance with recommendations of its respective manufacturer.
- F. No rocks, stones, metal, concrete, bricks, pavement pieces, wood, soil lumps or other hard materials too big to pass through a six (6") inch screen shall be permitted within six (6") inches of the pipe after it is laid in the trench. Any pipe endangered by such debris shall be subject to removal and disposal at the Contractor's expense.
- G. When pipe laying is not in progress, the open ends of installed pipe shall be closed by appropriate means to prevent the entrance of dirt and water. In the event ground water, sewage water or other potential contaminants enter any portion of the pipeline, after it is laid, cleaning and preliminary disinfection with a strong hypochlorite solution shall be done.
- H. Pipe lengths shall not be deflected at the joint to any greater degree than recommended by the manufacturer of the particular joint being used. Where deflections in excess of such recommendations are necessary, the appropriate specifications for the particular type of pipe being installed shall govern the mode of accomplishing such excessive deflections.

3.2 JOINTING PROCEDURES

- A. The particular method of making up pipe joints shall be governed by the type of pipe material and type of joint in accordance with the drawings and/or specifications.

3.3 ANCHORAGE

- A. All hydrants, plugs, caps, tees and bends shall be provided with a reaction backing or shall be restrained by attaching suitable metal rods, clamps, anchored fittings or harnessed joints, as shown on the plans or as specified so as to prevent movement.
- B. Reaction backing shall be of concrete, with steel reinforcement as required, unless otherwise shown on the drawings. Backing shall be placed between solid ground and the fitting or other part of the pipeline to be anchored; the area of bearing on the pipe and on the ground in each instance shall be that as indicated on the plans. The backing shall be so placed unless otherwise directed, that the pipe and fitting joints will be accessible for repair.

- C. Steel tie rods or clamps of adequate strength to prevent movement may be used instead of concrete backing. Steel tie rods or clamps shall be used to connect the hydrant watch valves to the main and to connect the hydrant to the water valves when shown on the drawings. Steel rods or clamps shall be painted with three coats of an approved bituminous paint or coat tar enamel.

3.4 BACKFILLING

- A. Backfilling shall be accomplished in a two-step procedure as follows: 1) partial backfill before leakage tests, and 2) completion of backfill after tests. Departure from this procedure due to traffic or other conditions shall be approved by the Engineer.

3.5 MAINTENANCE OF EXISTING DITCHES

- A. The Contractor shall use the utmost care in maintaining ditches and other waterways, and, if either bottoms or banks of such ditches are disturbed, they shall be promptly restored and maintained for the life of the guaranty period. Similar care shall be used in preventing damage to existing pavement by caving of trench walls and undermining such pavement. If pavement is damaged, the Contractor shall repair same at his own expense.

3.6 CLEARING SITE AND RESTORING DAMAGED SURFACES

- A. Upon completion of the backfill work, the Contractor shall immediately remove and dispose of all surplus materials including dirt and rubbish.
- B. Unless otherwise called for on the plans, the Contractor shall replace all pavement, sidewalks, sod, or other surfaces disturbed to a condition equal to that existing before the work was started, furnishing all materials, labor, equipment, etc., at no additional cost to the Owner.
- C. All restoration of lawns shall be performed in accordance with these specifications as a part of performing the work as specified herein.
- D. All restoration of driveways, sidewalks, roadways and shoulders (berms) shall be in accordance with these specifications as a part of performing the work as specified herein.
- E. Upon completion of the foregoing work, all tools and other property belonging to the Contractor shall be removed, and the site shall be left in good condition.

3.7 LEAKAGE TESTS

- A. All pipeline construction shall be subjected to hydrostatic leakage testing of each valved section, as it is completed, unless otherwise directed by the Engineer. All pipes, valves, fittings, etc. shall be laid in such a manner as to leave all joints watertight.
- B. Each section of pipe being tested shall be filled slowly with water, and, before applying the specified test pressure, all air shall be expelled from the pipe. The method of obtaining and placing test water(s) into the pipeline shall be approved by the Engineer.
- C. The test shall be observed by the Engineer or his designate. The Owner will furnish a pressure gauge for measuring the pressure on the water main. The Contractor shall furnish a suitable pump, pipes, bulkheads and all appliances, labor, fuel, and other appurtenances necessary to make these tests.

- D. The test pressure shall be maintained for sufficient length of time to allow for a thorough examination of joints and elimination of leakage where necessary. The pipeline shall be made absolutely tight under the test pressure.
- E. The Contractor shall drain each section of the waterline piping after it has been tested. If the drains are connected to valve or drain vaults, then, within a reasonable period of time after the test has been completed, the Contractor shall pump all water out of the vaults.
- F. In cold weather, immediately after testing a section of the waterline piping, the Contractor shall open all valves, air cocks, by-passes, and drains; shall drain that section of the pipeline, including the bonnets of all valves contained therein, and shall take all other precautions necessary to prevent injury due to freezing to the water main, piping and appurtenances.
- G. Every precaution must be taken to remove, valve-off, or otherwise protect delicate control equipment in or attached to pipelines to prevent damage or injury thereto.
- H. Leakage is defined as the quantity of water that must be supplied into the newly laid pipe, or any valved section thereof, as required to maintain the specified leakage test pressure after the pipe has been filled with water and the air expelled as herein required.
- I. In calculating leakage, the Engineer will not make allowance for any leakage at the valves, the removable bulkheads, etc.
- J. The evaluation of actual leakage to standard pressure leakage is calculated by the application of the ratio determined from the square root of respective pressures, other factors being equal.
- K. The test pressure shall be 250 psi unless otherwise specified elsewhere in these specifications. Testing procedure shall be as specified herein for the particular pipe material contained in the section tested and shall be subject to modification as required by a particular pipeline material specification or part thereof, as contained elsewhere in these specifications.
- L. For cast iron pipe (CIP) or ductile iron pipe (DIP), AWWA C 600 shall govern the test, except that the allowable leakage rate shall be 12 gpd per mile of pipe per inch of diameter.
- M. All defective materials and construction found in the pipeline as a result of leakage tests shall be corrected by removal of the defective materials and reconstruction with sound materials and construction. The entire section shall then be retested in accordance with the foregoing.
- N. Any testing performed without the knowledge of the Engineer shall not be considered a test for the purpose of this specification.
- O. The lack of hydrants, branch shutoff valves, or any other attachments to the line being tested shall not preclude the testing of each valved section as it is completed. In the event that hydrants, branch shutoff valves or any other attached appurtenances are not available for installation prior to testing of each valved section, then plugs or other approved means of containing line pressure must be utilized so as to test each valved section of main line as it is completed. A retest of each valved section will then be necessary after all appurtenances are installed. There will be no additional payment for any such retests.
- P. The Contractor shall provide all pressure test equipment. The Owner shall provide all test water required and shall provide test gauges.

3.8 DISINFECTION

- A. Prior to disinfection, all pipeline construction shall be flushed to remove any foreign material. Flushing shall be performed after completion and approval of the leakage tests. The minimum requirements for flushing are as follows:

<u>Pipe Size</u>	<u>Minimum GPM Required</u>
6"	220
8"	390
10"	610
12"	880
14"	1,200
16"	1,565
18"	1,980
20"	2,450
24"	3,500

- B. Flushing at these rates shall be continued for at least five (5) minutes. In the event the foregoing requirements cannot be met due to the Owner's facilities being inadequate, alternate rate(s) and duration(s) of flushing shall be used.
- C. Disinfecting water mains shall be in accordance with AWWA C 651 and as specified herein.
- D. The following disinfectants may be used: Chlorine or chlorine water; calcium hypochlorite; sodium hypochlorite solution, or chlorinated lime-water mixture. Chlorine shall be applied at one extremity of a pipe section via a corporation stop (installed in the top of the pipe by the Contractor) and bled at the opposite extremity of a properly segregated section. Precautions shall be taken to prevent dosed water from flowing into the potable water supply. All high points on the section treated shall be properly vented for air escape.
- E. The rate of applying the disinfectant shall provide at least 25 ppm (mg per liter) chlorine dose at the outlet end of the line section being treated. The disinfecting period shall be twenty-four (24) hours, and, at the end of this period, a chlorine residual of at least 10 mg per liter shall exist at the outlet end of the line.

In the event of unfavorable or unsanitary conditions of installation, poor packing, or high pH, the period of disinfection may be extended. For shorter periods of disinfection, higher dosages shall be required.

- F. Sterilizing water shall be disposed of in a satisfactory manner by the Contractor. If the foregoing disinfection procedure fails to provide thorough disinfection of the line, it shall be repeated as necessary in the pipeline for a period of 20 - 30 days after it is placed into operation.
- G. Tests for efficacy of sterilization shall be made by the Owner, and repeated sterilization shall be carried out by the Contractor when required.
- H. Contractor shall provide all disinfectants and disinfection equipment. Owner shall provide all test waters needed.

3.9 DISINFECTION (ALTERNATE METHOD)

- A. Application of disinfectant may be performed as follows:
1. While installing the main, a powdered calcium hypochlorite compound (HTH, perchloron, monochlor, or equal), shall be placed in the main at intervals such that the minimum quantity of disinfectant per 100 feet of main is as follows:

4" pipe	1 oz.
6" pipe	2 oz.
8" pipe	3 oz.
10" pipe	5 oz.
12" pipe	8 oz.
16" pipe	12 oz.
20" pipe	18 oz.
24" pipe	25 oz.
- B. Although the foregoing alternate method of disinfection precludes the performance of leakage tests and flushing prior to disinfection, the requirements pertaining to the disinfection period, requisite chlorine residual, repeating the disinfection procedure, leakage tests and flushing shall be met.

END OF SECTION 331413

SECTION 333100 - SANITARY SEWER SYSTEM

PART 1 - GENERAL

1.1 SUMMARY

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.
- B. Furnishing all labor, materials, tools, equipment, and services for all sanitary sewers as shown on the Drawings.
- C. Although such is not specifically indicated, furnish and install all supplementary or miscellaneous items, appurtenances, and devices incidental to or necessary for a functional and complete installation.

1.2 RELATED DOCUMENTS AND SECTIONS

- A. Section 013319 – Field Testing Requirements
- B. Section 310000 - Earthwork
- C. Section 312500 - Erosion Control Matting

1.3 PRODUCTS INSTALLED BUT NOT FURNISHED UNDER THIS SECTION

- A. Granular pipe bedding and cover material specified in Section 310000 - Earthwork
- B. Special backfill material specified in Section 310000 - Earthwork

1.4 SUBMITTALS

- A. Product Data
 - 1. PVC pipe, each type specified
 - 2. Ductile iron pipe
 - 3. Manhole castings
 - 4. Precast concrete manholes
 - 5. Manhole steps
- B. Shop Drawings
 - 1. Precast concrete manholes showing:
 - a. Orientation plan for each manhole or inlet indicating where all pipes connect.
 - b. The size and elevation of connecting pipes.
 - c. Details of drop connections.
 - d. Invert concrete channeling details.
 - e. Pipe to manhole connection details.

- f. Casting and step orientation.
- C. Samples
- D. Quality Control Submittals
 - 1. Design Data
 - 2. Test Reports
 - 3. Certificates
 - a. Evidence of current membership in specified manufacturer's associations.
 - b. Evidence of ODOT precertification for the manufacturing RCP pipe.
 - c. Evidence of National Precast Concrete Association (NPCA) certification for the manufacture of precast concrete manholes.
 - 4. Manufacturer's Instructions

1.5 REFERENCES

- A. ASTM A-48 Standard Specification for Gray Iron Castings
- B. ASTM C-76 Standard Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe.
- C. ASTM C-150 Standard Specification for Portland Cement
- D. ASTM C-270 Standard Specification for Mortar for Unit Masonry
- E. ASTM C-478 Standard Specifications for Precast Reinforced Concrete Manhole Sections
- F. ASTM C-990 Standard Specification for Joints for Concrete Pipe, Manholes, and Precast Box Sections Using Preformed Flexible Joint Sealants
- G. ASTM C-1173 Standard Specification for Flexible Transition Couplings for Underground Piping Systems
- H. ASTM D-2321 Standard Practice for Underground Installation of Flexible Thermoplastic Sewer Pipe
- I. ASTM D-3034 Standard Specification for Type PSM Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings
- J. ASTM D-3212 Standard Specification for Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals
- K. ASTM F-477 Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe
- L. ASTM F-679 Standard Specification for Poly(Vinyl Chloride) (PVC) Large Diameter Plastic Gravity Sewer Pipe and Fittings

- M. ANSI/AWWA C111/A21.11 American National Standard for Rubber-Gasket Joints for Ductile-Iron and Gray-Iron Pressure Pipe and Fittings
- N. ANSI/AWWA C151/A21.51 American National Standard for Ductile-Iron Pipe, Centrifugally Cast in Metal Molds or Sand-Lined Molds, for Water and Other Liquids
- O. AWWA C900 Polyvinyl Chloride (PVC) Pressure Pipe, 4 in. Through 12 in., for Water Distribution

1.6 PROJECT CONDITIONS

A. Existing Conditions

1. Verify locations of underground utilities.
2. Protect existing structures and utilities from damage. Repair if damaged by this work.
3. Do not change pipe sizes without securing written approval of Engineer.

B. Field Measurements

1. If it becomes necessary to change location of sanitary sewer lines due to underground utility interference, secure approval of Engineer.
2. If Contractor initiated, make changes approved by the Engineer without added cost to Owner.

1.7 PROJECT CONDITIONS

A. Existing Conditions

1. Verify locations of underground utilities.
2. Protect existing structures and utilities from damage. Repair if damaged by this work.
3. Do not change pipe sizes without securing written approval of Engineer.

B. Field Measurements

1. If it becomes necessary to change location of sanitary sewer lines due to underground utility interference, secure approval of Engineer.
2. If Contractor initiated, make changes approved by the Engineer without added cost to Owner.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Acceptance at Site

1. All material and all equipment shall be subject to visual inspection and acceptance or rejection after delivery to the site of the work. All rejected material shall immediately be removed from the site.

1.9 SEQUENCING AND SCHEDULING

- A. Perform no pipe work in fill areas until embankment or fill has been completed to at least two (2) feet above proposed top of pipe and fill has been properly compacted.

PART 2 - PRODUCTS

2.1 PIPE

A. Polyvinyl Chloride Pipe (PVC) 4" - 15" Diameter

1. All polyvinyl chloride pipe in this size range shall conform to ASTM D-3034 SDR 26, shall be integral bell and spigot type, with joints conforming to ASTM D-3212 and elastomeric seals conforming to ASTM F-477.
2. All pipe and fittings shall be marked or stenciled in conformance with ASTM D-3034. All gaskets shall be marked or stenciled with the ASTM specification designation, name or trademark of the manufacturer, and pipe size.
3. Acceptable manufacturers shall be current members of the Uni-Bell Plastic Pipe Association.

B. Polyvinyl Chloride Pipe (PVC) 18" - 36" Diameter

1. All large diameter polyvinyl chloride pipe shall conform to ASTM F-679 PS46, shall be integral bell and spigot type, with joints conforming to ASTM D-3212 and elastomeric seals conforming to ASTM F-477.
2. All pipe and fittings shall be marked or stenciled in conformance with ASTM F-679. All gaskets shall be marked or stenciled with the ASTM specification designation, name or trademark of the manufacturer, and pipe size.
3. Acceptable manufacturers shall be current members of the Uni-Bell Plastic Pipe Association.

C. Ductile Cast Iron Pipe

Ductile cast iron pipe shall be designed in accordance with ANSI/AWWA C150/A21.50 and manufactured in accordance with ANSI/AWWA C151/A21.51. Pipe shall be coated with a bituminous material on the outside and shall be cement mortar lined in accordance with ANSI/AWWA C104/A21.4. Joints shall be mechanical or push-on in conformance with ANSI/AWWA C111/A21.11 incorporating rubber gaskets. Mechanical joints shall be used wherever joint restraint is required. Bolts for mechanical joints shall be made of either high strength cast iron containing a minimum of 0.50 percent copper or high strength low alloy steel conforming to ANSI/AWWA C111/A21.11.

1. The minimum wall thickness of the pipe barrel shall be that indicated in ANSI A21.50 (AWWA) C150 for laying condition "2", 150 psi internal working pressure and a surge pressure of 100 psi and 5 feet depth of cover unless otherwise indicated on the drawings.

2. All pipe shall be marked or stenciled in conformance with ANSI/AWWA C151/A21.51. All gaskets shall be marked or stenciled with the ASTM specification designation, name or trademark of the manufacturer, and pipe size.
3. Within structures, flanged joints shall conform to AWWA C110 or ANSI A21.10. Appurtenances used to make flanged joints shall include: 1/16th thick red rubber gaskets, bolts having American Standard Unfinished Hexagonal head and nut dimensions in conformance with ANSI B18.1 and material for bolts and nuts shall conform to ASTM A-575 or A-576.
4. The ductile iron pipe, fittings and appurtenances buried underground, shall be encased with 8 mil polyethylene film conforming with AWWA C105, unless noted otherwise.
5. Fittings shall be cast grey iron/ductile iron castings conforming to the latest applicable AWWA and/or ANSI specifications for pressure fittings with end conditions as specified herein. AWWA C110 (ANSI A21.10) shall be applicable for all cast grey iron/ductile iron fittings.
 - a. Fittings for pipe sizes of 12 inch diameter and smaller shall be rated for 250 psi working pressure in accordance with AWWA C110.
 - b. The end conditions of each fitting shall be as required to accommodate the jointing requirements for the particular pipe material being connected to the fitting in accordance with the piping layout shown on the plans. The particular pipe material to be connected to the fitting is specified elsewhere in these specifications.
 - c. The outside surface of all cast grey iron/ductile iron fittings shall be shop coated with either a coal tar or asphalt base bituminous material. If this coating material is found to be damaged prior to the pipe trench being backfilled, the Contractor shall provide and apply additional material of that required to repair the damages. The Contractor shall have sufficient coating material available at the job site prior to laying the pipe.
7. Acceptable manufacturers are:
 - a. U.S. Pipe
 - b. Tyler Pipe

D. PVC Pressure Rated Pipe

1. PVC pressure pipe shall be designed in accordance with AWWA C909 and ASTM F-1483 and shall be minimum Thickness Class DR 18. The bell section shall be as hydrostatically strong as the pipe wall. Joints for PVC pressure pipe shall be push-on with elastomeric ring in conformance with ASTM D-3139. Gaskets shall conform to ASTM F-477.
2. All pipe and fittings shall be marked or stenciled in conformance with AWWA C909. All gaskets shall be marked or stenciled with the ASTM specification designation, name or trademark of the manufacturer, and pipe size.
3. Fittings shall conform to Paragraph 2.1(B)(6) of this Section.
4. Acceptable manufacturers shall be current members of the Uni-Bell Plastic Pipe Association.

2.2 PRECAST CONCRETE MANHOLES

- A. All precast manhole units shall be manufactured in accordance with the provisions of ASTM C-478.
- B. Joints between manhole units shall be gasketed and shall comply with the requirements of ASTM C-443. All gaskets shall be marked or stenciled with the ASTM specification designation, name or trademark of the manufacturer, and pipe size.
- C. The standard length of riser units shall be 48 inches. Lengths of 32 inches or 16 inches shall be used to meet required dimensions.
- D. Openings for connecting pipes in riser units, bottom riser units, integral base units, and for access in flat slabs shall be preformed or cored by the manufacturer. Cut-out openings shall be made immediately after the pipe is removed from the casting form.
- E. Connectors between new precast concrete manholes and pipes shall be made by casting the connector integrally with the manhole wall. The connectors shall be composed of EPDM with stainless steel take down bands for compressing the connector against the outside diameter of the pipe. The connectors shall comply with the requirements of ASTM C-923, and shall be "Z-Lok" Type as manufactured by A-Lok Products; or an approved equivalent.
- F. All openings in existing manholes shall be field cored and shall have mechanical connectors complying with the requirements of ASTM C-923 and shall be equal to Kor-N-Seal as manufactured by NPC, Inc., Milford, NH.
- G. Annular spaces at pipe entrances shall be field sealed with a one component, hydraulic cement based, fast setting repair mortar equal to Thoro Products Waterplug as manufactured by ChemRex Inc., Shakopee, MN.
- H. The top four (4) inches to twelve (12) inches of the manhole shall provide for adjustment of casting to grade. Adjustment shall be through the use of a maximum of two (2) precast concrete adjusting collars.
- I. Where pressure tight manhole frames and covers are specified, threaded inserts shall be cast in eccentric cones or flat slab tops, and holes formed or cored in adjusting rings to match bolt size and spacing specified for manhole casting.
- J. Where required by the drawings, manhole coatings shall be an acrylic modified cementitious, high-build, waterproof coating equal to Thoroseal Foundation Coating as manufactured by ChemRex Inc., Shakopee, MN.
- K. Precast concrete shall be manufactured by an NPCA certified plant.

2.3 MANHOLE STEPS

- A. All steps shall be minimum of twelve (12) inches in width with safety side lugs to prevent slipping and shall conform to the latest OSHA requirements. Manhole steps shall be of polypropylene plastic reinforced with a 3/8", No. 60 grade epoxy coated reinforcing rod.
- B. Manhole steps shall conform to the requirements of ASTM C-478.

- C. Acceptable manufacturers are:
 - 1. American Step Company, Inc.
 - 2. Lane International, Inc.
 - 3. M. A. Industries, Inc.

2.4 CASTINGS

- A. All castings shall be true to pattern and free from cracks, gas holes, flaws and excessive shrinkage. Surfaces shall be free from burnt-on sand and shall be reasonably smooth. Runners, fins, risers and other cast-on pieces shall be removed. Castings for manhole frames and covers and for any other purpose under these specifications shall conform to all the requirements for Class No. 35B for Gray Iron Castings of the ASTM A-48. All castings shall be commercially machineable and, in the case of manholes, the frame and cover shall be so machined that it will be impossible to rock the cover after it has been seated in the proper position in the frame.
 - 1. Manhole frames and covers shall be as detailed on the Drawings.
 - 2. Frame and cover shall be painted with one coat of the manufacturer's standard asphaltum paint.

2.5 MASONRY MORTAR

- A. Mortar shall conform to ASTM C-270, Type M, but shall not contain masonry cement.
- B. Mortar shall be UltraMortar Type M as manufactured by UltraKote Products, Inc. or Lafarge Mortar Cement, Type M as manufactured by Lafarge Corporation, or approved equal.
- C. Only sufficient mortar shall be prepared for immediate use, and any mortar that has set shall not be retempered or used in the work.
- D. Setting accelerators or anti-freeze compounds shall not be used.

2.6 PREFORMED BUTYL MASTIC SEALANT

- A. Preformed butyl mastic sealant material shall be furnished in 1-inch wide strips conforming to the requirement of ASTM C-990.
- B. The butyl mastic sealant shall be Bidco C-56 as manufactured by Bidco Sealants, Inc., Park Hills, MO or equal.

2.7 COUPLINGS

- A. Couplings for connecting dissimilar pipe materials or pipe sizes shall be a rubber type coupling with a sealing "O" ring under each of two sealing clamp bands and a Type 316

stainless steel shear ring. Coupling shall be manufactured with natural and synthetic rubbers conforming to ASTM C 425 and ASTM C 1173.

- B. Coupling shall be Flex-Seal Adjustable Repair Coupling as manufactured by the Mission Rubber Company, Corona, CA, or approved equal.

PART 3 - INSTALLATION

3.1 ALIGNMENT AND GRADE

A. Horizontal and Vertical Control

1. All horizontal and vertical control required for the complete layout and performance of the Work under this contract shall be done by a registered surveyor at the Contractor's expense, and any observations by the Engineer of the Contractor's methods will not relieve the Contractor of his responsibility.
2. The Contractor shall be solely responsible for the accuracy of all horizontal

- B. Alignment and grade shall be established by means of a laser beam.

- C. The Contractor shall furnish all material and labor to establish line and grade of the generated laser beam from the benchmarks and control points indicated on the Drawings. The laser shall be securely anchored and checked periodically by the Contractor. The laser calibration shall be demonstrated when requested by the Engineer. Strict adherence to the manufacturer's operation procedure shall be observed. Only qualified and trained employees may be assigned to install, adjust, or operate laser equipment, and proof of qualifications of the equipment operator must be available at all times. Areas in which lasers are used must be posted with standard laser warning placards, and the laser beam shall be turned off when not needed. During rain, snow, dust, excessive heat, or fog the operation of laser systems shall be prohibited where practicable because of beam scatter.

3.2 PIPE INSTALLATION

- A. All pipe installation shall conform to the trench and bedding details shown on the Drawings.
- B. PVC pipe shall be installed in full compliance with ASTM D-2321. Clay pipe shall be installed in full compliance with ASTM C-12. All concrete pipe shall be installed in conformity with recommended practices published by the American Concrete Pipe Association in the "Concrete Pipe Installation Manual".
- C. Only one type and strength of pipe shall be used between any two consecutive manholes, unless otherwise shown on the Drawings.
- D. After the trench has been excavated and the pipe bedded, the pipe shall be laid to the line and grade as shown on the Drawings. All joints shall be made as hereinafter specified. In no case shall any material except bedding material be placed under the bell of the pipe to secure proper grade.

- E. Prior to being lowered into the trench, each pipe shall be carefully inspected and those which are damaged or not meeting the specified requirements shall be rejected and clearly marked as rejected and removed from the Work. Satisfactory means shall be used to hold the pipe in line until embedment of pipe is complete. Precautions shall be taken to insure that the spigot end of the pipe being laid is pushed the proper depth into the bell of the preceding pipe.
- F. All conduit shall be laid starting at the outlet end and laid with the bell end upstream.
- G. In no case shall more than thirty (30) feet of trench be opened in advance of the pipe laying operations.
- H. Conduit shall not be laid in water, mud, or any otherwise unsuitable trench. No drainage shall run through the newly laid pipe. All sewers shall be temporarily capped with a watertight seal at the open ends at the completion of each day's work and no drainage water shall be permitted to flow through the sewer.
- I. All trenches and excavations shall be backfilled as specified as soon as possible after the pipe is laid and jointed. Where concrete encasement or cradle is used, pipe shall not be backfilled for at least twenty four (24) hours after placing concrete except that pipe may be covered to a depth of not to exceed sixteen (16) inches over the top of the pipe.

3.3 JOINTING

A. Polyvinyl Chloride (PVC) Pipe

1. Dust, dirt and foreign matter shall be removed from joint surfaces. When jointing pipe using the required compression type joint, a lubricant recommended by the gasket manufacturer shall be used. The gasket shall be lubricated by drawing it through lubricant held in the hand of the worker, thus coating the entire surface of the gasket.
2. When laying the pipe in concrete bedding, care shall be exercised to prevent the joint materials from coming in contact with the fresh concrete until after the joint has been completed.

B. Ductile cast iron push-on joints

1. The gasket seat and the gasket shall be thoroughly cleaned and should be wiped with a clean cloth and a thin film of lubricant applied to the inside surface of the gasket that will come in contact with the entering pipe. Use only the lubricant furnished with the pipe. In no case shall a mineral oil or petroleum base lubricant be used.
2. The plain end of the pipe to be jointed shall be thoroughly cleaned and started into the socket so that it is in contact with the gasket. In some cases it may be desirable to apply a thin film of lubricant to the outside of the plain end for about one (1) inch back from the end. The joint is then completed by exerting sufficient force on the entering pipe so that its plain end is moved past the gasket until it makes contact with the base of the socket. Any manufacturer approved method may be used to home the pipe.

3. When laying the pipe in concrete bedding, care shall be exercised to prevent the joint materials from coming in contact with the fresh concrete until after the joint has been completed.

3.4 PERMISSIBLE DEFLECTION AT JOINTS

- A. No pipe deflections or springing of joints, to effect a change in direction will be allowed, except by permission or direction of the Engineer, or as shown on the Drawings. Any permitted or directed deflection shall be a maximum of 80 percent of the allowable deflection value established by the pipe manufacturer.

3.5 MANHOLES

- A. Build each manhole to dimensions shown on Drawings and at such elevation that pipe sections built into wall of manhole will be true extensions of line of pipe.
- B. Set frames for manholes, within areas to be paved, to final grade. In asphalt pavement, surround frames set to grade with a ring of compacted asphalt concrete base material immediately after backfilling operations are complete. Place asphalt concrete mixture up to one (1) inch below top of frame, slope to grade, and compact with hand tamp.
- C. Precast bases shall be placed on a bed of crushed gravel or crushed limestone, meeting AASHTO M 43 gradation, having a minimum thickness of three (3) inches. The bedding shall be compacted and provide uniform support for the entire area of the base.
- D. Provision shall be made for a minimum of four (4) inches and a maximum of twelve (12) inches of precast concrete grade rings between the uppermost precast section and the bottom of the cast iron manhole frame in order to set manhole cover to grade.
- E. No more than two lifting holes or other lifting devices shall be utilized for handling the precast sections. All lifting holes shall be acceptably sealed with a hydraulic cement based, fast setting repair mortar, meeting the requirements of Article 2.2 of this Section, prior to backfilling around the manhole.
- F. Inverts shall be formed to the equivalent of half-pipes in concrete and as follows:
 1. Carry concrete out to the manhole wall with a slope of $\frac{1}{2}$ in./ft. from the top of the half-pipe.
 2. The bottoms of all manholes shall be channeled to conduct flow in the planned direction. Channels shall be the true shape of the lower half of the sewer pipe and shall match inverts of connecting pipe at the manhole wall.

3.6 BRANCH CONNECTIONS

- A. In general, provision shall be made in the sewers for service connections by inserting a wye branch in the sewer at the location shown on the Drawings, where required or ordered, for each service connection with a branch size called for by the Drawings but never less than six (6) inch, for sewers ten (10) feet or less in depth. Where indicated on the plans, the Contractor shall construct a riser, as per detail, in such manner, that the top

of the riser shall be not less than seven (7) feet below grade or at such elevation as to properly receive the required service connection, with full regard to elevation of service sewer and slope from building or structure to the sewer which shall not be less than one percent (1%).

- B. The approximate location of service connections are shown on the Drawings based upon available information. The Owner may increase the number of connections or delete some connections as the sewer is being built.
- C. Openings at the outer ends of the connections shall be closed and sealed with approved stoppers when connection is not immediately placed into service.

3.7 MAINTAINING SEWAGE FLOW

- A. The Contractor shall be required to maintain the flow in all existing live sewers during construction and the method employed shall be approved by the Engineer.

3.8 REPLACING, MOVING AND REPAIRING OF EXISTING UTILITIES

- A. The Contractor shall replace, move, support, or repair and maintain all pipes for water, steam, air or gas, and all wire conduit(s), and all other structures encountered in the work and repair all damage done to any of the said structures and appurtenances through his acts or neglect and shall keep them in repair during the life of the Contract. The Contractor shall in all cases leave them in as good condition as they were previous to the commencement of the work and to the full satisfaction of the Owner.

3.9 CONNECTION TO EXISTING SEWER SYSTEM

- A. The Contractor shall make connections to the existing sewer system as shown on the Drawings. The connections shall be made by the Contractor at such hours that will cause the least disturbance to the flow in the existing sewer system. The Contractor, however, shall notify the Engineer at least five working days in advance of the time he desires to make the connections and no such connections shall be made until the permission of the Engineer is obtained.

3.10 CLEAN-UP

- A. Before final acceptance for the Work, the Contractor shall clear the sewers of any mortar, dirt or other refuse that may have been left or accumulated in the sewers. All manholes and other structures shall be cleared of all forms, scaffolding, bulkheads, centering, surplus mortar, rubbish or dirt and left in a clean and proper condition.

3.11 DEFECTS TO BE MADE GOOD

- A. If, at any time before the completion of the contract, any broken pipes, or any defects, are found in the sanitary sewers or in any of their appurtenances, the Contractor shall cause the same to be removed and replaced by proper material and workmanship, without extra compensation for the labor and material required. All materials shall be carefully

examined by the Contractor for defects before placing and any found defective shall not be placed in the line.

END OF SECTION 333100

SECTION 333913 - MANHOLES AND COVERS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes precast, cast-in-place manholes and covers, modifications to existing manholes as shown on the Drawings or specified, and required for the storm sewer, sanitary sewer, and other applications.
- B. Furnish all labor, materials, equipment and incidentals necessary to provide all new precast and cast-in-place manholes shown on the Drawings and Schedules and as specified, or otherwise required to complete the work. Include any modifications required to existing manholes.

1.2 REFERENCES

- A. The specifications in this Section are subject to the administrative and procedural requirements specified in Division 1, as well as the broader requirements of the General Conditions.
- B. Reference Standards:
 - 1. ASTM C139, Specification for Concrete Masonry Units for Construction of Catch Basins and Manholes.
 - 2. ASTM C140, Methods of Sampling and Testing Concrete Masonry Units.
 - 3. ASTM C207, Specification for Hydrated Lime for Masonry Purposes.
 - 4. ASTM C361, Specification for Reinforced Concrete Low-Head Pressure Pipe.
 - 5. ASTM C443, Specifications for Joints for Circular Concrete Sewer and Culvert Pipe, Using Rubber Gaskets.
 - 6. ASTM C478, Precast Reinforced Concrete Manhole Sections.
 - 7. ASTM C497, Methods of Testing Concrete Pipe, Sections, or Tile.
 - 8. ASTM C780, Preconstruction and Construction Evaluation of Mortars for Plain and Reinforced Unit Masonry.
 - 9. AWWA C302, Standard for Reinforced Concrete Pressure Pipe, Noncylinder Type, for Water and Other Liquids.

1.3 SUBMITTALS

- A. In accordance with Section 013300.
- B. Shop Drawings: Comply with Section 013300 and provide the following:
 - 1. Plans, elevations, and sections.
 - 2. Details of penetrations, connections, and anchorages.
- C. Product Data: Comply with Section 013300 and provide the manufacturer's name, specification, and experience.

- D. Product/Material Certifications Comply with Section 013300.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Precast Concrete Manholes:

1. United Precast, Inc.
2. E.C. Babbert, Inc.
3. Mack Industries, Inc.
4. Or approved equal.

B. Joints:

1. Press Wedge II.
2. Kor 'N' Seal.
3. Link Seal.
4. Interpace.
5. Or approved equal.

C. Frames and Covers

1. East Jordan Iron Works, Model 1661Z1
2. Neenah Corp., Model R-1762
3. Or approved Equal

2.2 MATERIALS

- A. Structures: Conform in shape, size, dimensions, material, and other respects to the details shown on the Plans.

- B. Concrete: Conform to the requirements of Division 03.

- C. Reinforcement: Conform to the requirements of Division 03.

D. Cast-In-Place Manholes:

1. Conform to the requirements of Division 03 for concrete, reinforcing steel, and appurtenances.

E. Precast Concrete Manholes:

1. Precast bottoms may be used in lieu of cast-in-place concrete, provided the bottoms are constructed monolithically with the bottom manhole riser section.
2. Conform to the requirements of ASTM C478.
3. Minimum wall thickness to be 5 inches for 48-inch diameter risers and 6 inches for 60-inch diameter risers. Wall thickness for risers larger than 60 inches in diameter to be shown or specified on the Drawings.

4. Cast openings for pipes into the precast units.
5. Design to withstand all loads imposed including earth pressure, vehicle loads, and construction loads.

F. Masonry Work:

1. Masonry units to be solid hard burned, grade MS brick conforming to the requirements of ASTM C32.
2. Mortar: Composed of one part of Portland cement to two parts of sand by volume.

G. Joints:

1. Sanitary Manholes
 - a. Conform to ASTM C443.
 - b. Pipe entering manholes at openings:
 - 1) Seal by means of flexible rubber gaskets, sleeves, or mechanically expandable seals.
 - 2) Where flexible seals cannot be used openings shall be sealed with non-shrink grout.
2. Storm Manholes
 - a. Seal with non-shrink grout.

H. Frames and Covers:

1. ASTM A48-76, Class 35 cast iron construction, machined flat bearing surface, and be removable.
2. Manhole cover must have a gasket, concealed pick hole, and be stamped "SEWER".

I. Steps:

1. 3/4- inch diameter formed FRP rungs

J. Drop Connections:

1. Pipe and Fittings: Schedule 80 PVC
2. Bond to manhole as shown on the Drawings.

K. Non-shrink Grout:

1. Non-metallic grout shall be used for all exposed grouted conditions.
2. Grout shall be stored, mixed and placed in strict accordance with the manufacturer's instructions.
3. Acceptable Manufacturers
 - a. Masterflow 713 by Master Builders, Cleveland, Ohio.
 - b. Euco N-S by Euclid Chemical Co., Cleveland, Ohio.
 - c. Crystex by L & M Construction Chemicals, Omaha, Nebraska.
 - d. Or approved Equal.

2.3 SOURCE QUALITY CONTROL

A. Tests:

1. Perform tests for each type of item in accordance with the following methods of ASTM as a minimum:
 - a. ASTM C140, Methods of Sampling and Testing Concrete Masonry Units.
 - b. ASTM C497, Methods of Testing Concrete Pipe, Sections, or Tile.
 - c. ASTM C780, Preconstruction and Construction Evaluation of Mortars for Plain and Reinforced Unit Masonry.
2. Each test shall be witnessed by a State of Ohio registered Professional Engineer who shall sign and seal all copies of test reports.
3. Ship only after test reports have been satisfactorily reviewed.

B. Inspection:

1. Inspect all products during manufacture and before shipment.
2. Verify measurements.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Inspect all items immediately upon delivery to site for damage.
- B. All surfaces shall be smooth, free of voids, pores, or unreinforced areas.

3.2 PREPARATION

- A. Delivery, storage, and protection: Comply with Section 01600.

3.3 INSTALLATION

- A. Install items in complete conformance with the shop drawings and manufacturer's instructions.
- B. Install damaged items only after satisfactory repairs are made in accordance with manufacturer's written instructions. Factory repair or replace items having major damage. Only minor field repair will be permitted as approved by Engineer in writing.
- C. Cast-In-Place Manholes:
 1. Form concrete base and place on a compacted subbase consisting of a 6-inch minimum thickness of #57 crushed aggregate and extending at least 1 foot beyond the structure.
 2. Cast base monolithically to at least 12 inches above the top of the highest pipe entering the manhole, except where a drop connection is to be installed.
 3. Base Walls and Bottom:
 - a. At least of the thickness shown.
 - b. Reinforce as shown.
 - c. Construction joints as shown or where approved.

4. Take special care in placing the concrete around the bottom of the pipes to obtain a waterproof structure.
5. Finish concrete in accordance with Section 033000.

D. Precast Manhole Sections:

1. Cast base section monolithically with the lower riser section.
2. Place base section on a compacted subbase consisting of a 6-inch minimum thickness of #57 crushed aggregate, extending at least 1 foot beyond the manhole exterior so as to provide uniform support for the entire base.
3. Set riser sections vertical with steps and sections in true alignment.
4. Install sections, joints and gaskets in accordance with manufacturers' recommendations and as specified herein.
5. Remove lifting cables, seal lifting holes tight with a solid rubber plug driven into hole, and fill the remaining void with non-shrink grout.

E. Inverts:

1. Conform accurately to the size and elevation of the adjoining pipes.
2. Side Inverts: Curve smoothly into main pipe.
3. Main Inverts Where Direction Changes: Lay out in smooth curves of the longest possible radius which is tangent to the centerlines of adjoining pipelines.

F. Grading Rings:

1. Grading Rings or Brick Stacks:
 - a. Use on all manholes where required.
 - b. Construct on the roof slab or cone section on which the manhole frame and cover will be placed.
 - c. Reinforce all precast rings with one (1) No. 3 gage wire or equivalent.
2. Height of the Stack: As is necessary to bring the manhole frame to the proper grade, but in no case higher than 12 inches.
3. Brick Work: As specified herein.

G. Masonry:

1. Thoroughly wet brick before laying in the mortar bed.
2. Lay in mortar so as to form full bed, end and side joints in one operation.
3. Joints: Not wider than 3/8-inch nor narrower than 1/4-inch.
4. Bricks shall be laid by experienced bricklayers only.
5. Plaster the exterior face of all masonry walls with a 1-inch thick smooth cement mortar coating. Cure with wet burlap for a period of 48 hours. Continuously wet burlap during this period.

H. Stubs for Future Connections:

1. Install as shown or required for connections, cast iron sleeves, bell end tile or reinforced concrete pipe stubs with approved watertight plugs in manholes.
2. Provide all materials and work for construction of pipe stubs, sleeves or couplings for future connections where shown.

I. Bulkheads:

1. Construct all bulkheads indicated as required to temporarily restrict flow for construction purposes.
2. Construct bulkheads a minimum of 12 inches thick of solid concrete brick and mortar.
3. Plaster at least one face of bulkhead with 1-inch thick mortar coating to provide watertightness.
4. Remove temporary bulkheads when directed by the Engineer.

J. Modification of Existing Manholes:

1. Modify existing structures as indicated to connect new pipes, remove old pipes, repair or otherwise alter the existing condition.

K. Grading at Manholes:

1. Build all manholes in unpaved areas as shown or directed to an elevation higher than the original grounds.
2. Surrounding Area:
 - a. Ground Surface: Grade to drain away from the manhole.
 - b. Fill: Place to the level of the upper rim of the manhole frame and then evenly grade surface on a 1 to 5 slope to the finished surrounding ground unless otherwise shown.
3. Install all manholes constructed in new or existing paved areas such that the top of casting elevation matches the pavement elevation and grading.

L. Channel Shaping:

1. Shape concrete channel as shown after walls are established and all pipes have been connected. Make allowance for concrete protective coating in shaping concrete channel.

3.4 FIELD QUALITY CONTROL

A. Manhole Testing

1. All manholes shall be vacuum tested in accordance with ASTM C 1244-93. The test head shall be placed at the top of the manhole in accordance with the manufacturer's recommendations.
2. A vacuum of ten inches of mercury shall be drawn on the manhole, the valve on the vacuum line of the test head closed, and the vacuum pump shut off. The time shall be measured for the vacuum to drop one inch.
3. The manhole shall pass if the time for the vacuum reading to drop from ten inches of mercury to nine inches of mercury meets or exceeds the values indicated in the following table. The times in the table are listed in seconds.

	Diameter (Inches)								
	30	33	36	42	48	54	60	66	72
Depth Feet	Time Seconds								
8	11	12	14	17	20	23	26	29	33
10	14	15	18	21	25	29	33	36	41
12	17	18	21	25	30	35	39	43	49
14	20	21	25	30	35	41	46	51	57
16	22	24	29	34	40	46	52	58	67
18	25	27	32	38	45	52	59	65	73
20	18	30	35	42	50	53	65	72	81
22	31	33	39	46	55	64	72	79	89
24	33	36	42	51	59	64	78	87	97
26	36	39	46	55	64	75	85	94	15
28	39	42	49	59	69	81	91	101	113
30	42	45	53	65	74	87	98	108	121

4. If the manhole fails the initial test, necessary repairs shall be made by an approved method. The manhole shall then be re-tested until a satisfactory test result is obtained.

B. Brick Tests:

1. Obtain and test a minimum of 6 specimens from each shipment of materials to the project site.
2. Perform compressive strength, weight, and dimensional tests on specimens. Tests to conform to ASTM C140, Methods of Sampling and Testing Concrete Masonry Units.

C. Mortar:

1. Test each batch of mortar mixed for and during actual construction.
2. Obtain three 2-inch mortar cube specimens for each batch.
3. Perform compressive strength tests in accordance with ASTM C780, Preconstruction and Construction Evaluation of Mortars for Plain and Reinforced Unit Masonry, in particular, Annex A6, Compressive Strength of Molded Masonry Mortar Cylinders and Cubes.

3.5 CLEANING

- A. Prevent the entrance of dirt and debris into the manhole and connecting pipelines.
- B. Remove all dirt and debris resulting from the construction operations from the manhole interior and connecting pipelines before the structure is placed in service.

END OF SECTION

SECTION 352226 - SLIDE GATES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Divisions 1 through 16 Specification sections, apply to work of this section.

1.2 DESCRIPTION OF WORK

- A. This section includes the furnishing and installation of wall thimbles (if applicable), gate frames, sluice gates, slide gates, floor stands, extension stems, stem guides, operating devices, position indicators, wall brackets, floor boxes, anchors, and all appurtenances.
- B. Sluice gates, slide gates, operators, and appurtenances shall be as shown on the Drawings, scheduled, as specified.
- C. Motors and electrical work incidental to installation and operation of sluice gates and slide gates shall be included herewith unless otherwise directed under other Contract Items.
- D. Custom-manufactured slide gates shall be as specified herein and listed in the gate schedule, complete with frame, slide, guides, stem, stem guides, seals, lifting operating mechanism as required to complete the installation.
- E. The unit shall be constructed and operate in accordance with manufacturer's instructions.

1.3 QUALITY

- A. Manufacturer: Company specializing in manufacturing the Products specified in this section with minimum of 100 installations of water control gates. The Project Manager assigned to this project shall have a minimum five years documented experience designing and manufacturing similar water control gates.
- B. The fully assembled gates shall be shop inspected, tested for operation and leakage, and adjusted before shipping. There shall be no assembling or adjusting on the job sites other than for the lifting mechanism.
- C. Performance
 - 1. Sluice gates shall be substantially watertight under the design head conditions. Under the design seating head, the leakage shall not exceed 0.05 US gallons per minute per foot of seating perimeter. Under the design unseating head, leakage shall not exceed 0.05 US gallons per minute per foot of perimeter.
- D. Equipment Rating: Certification requirements
- E. Sluice gates and their appurtenances shall conform to latest revisions and applicable portions of:

1. ASTM - American Society for Testing and Materials.
2. AWWA C542-16 – Electric Motor Actuators for Valves and Slide Gates.
3. AWWA C561-14 – Fabricated Stainless Steel Slide Gates.
4. AWWA C562-12/14 – Fabricated Aluminum Slide Gates

F. The manufacturer's shop welds, welding procedures and welders shall be qualified and certified in accordance with the requirement of the latest edition of AWS Sections D1.1, 1.2 and 1.6.

G. The gate manufacturer shall be ISO 9001:2015 certified.

H. Qualification of Installers: Use adequate numbers of skilled workmen who are thoroughly trained and experienced in the necessary crafts and who are completely familiar with the specified requirements and methods needed for proper installation of the work in this Section.

1.4 PROTECTION

A. All gates shall be shipped, stored, and installed in such a way as to avoid warping the frame and to maintain tolerances between seating faces.

1.5 SUBMITTALS

A. The Contractor shall submit manufacturer's technical data and application instruction in accordance with the General and Supplementary Conditions and Division 1 Specifications and any additional information listed herein.

B. Product Data: Submit manufacturer's technical data and application instructions.

C. Shop Drawings:

1. The manufacturer shall submit for approval drawings showing the principal dimensions, general construction and material used in the gate and lift mechanism.
2. Slide gates, operators, and appurtenances shall be as shown on the Drawings, scheduled, as specified, or as ordered.
3. Indicate equipment location, rough-in and anchor placement dimensions and tolerances, clearances required and elevation/design requirements.
4. Manufacturer's recommended installation procedures which, when approved by the Engineer, will become the basis for accepting or rejecting actual installation procedures used on the Work.
5. Test data required elsewhere in this Section.

D. The manufacturer shall submit for approval complete engineering design calculations and compliance with AWWA C561 standards latest edition.

E. Upon completion of this portion of the Work, and as a condition of its acceptance, provide an Operation and Maintenance manual.

1.6 PRODUCT HANDLING

- A. Comply with pertinent provisions of Section 016600.
- B. All gates shall be shipped, stored, and installed in such a way as to avoid warping the frame and to maintain tolerances between seating faces.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Sluice and Slide gates shall be manufactured by:
 - 1. RW Gate
 - 2. Hydro Gate
 - 3. Golden Harvest
 - 4. Or approved equal.
- B. The naming of a particular manufacturer herein does not imply that manufacturer's standard equipment is suitable or approved for installation on this project. Slide gates shall meet all requirements of this specification without exception.

2.2 SLIDE GATES (STAINLESS STEEL)

- A. The Slide Gates shall be manufactured in accordance with the latest version of AWWA C561 and shall be constructed of stainless steel ASTM 304L.
- B. Materials of construction shall conform to the following ASTM Standards:

Frame, Slide and Reinforcing	ASTM A240/A240M, Type 304L
Stems and retainer bars	ASTM A276, Type 304L
Fasteners	ASTM F593/D594, Alloy Group 1 or 2, or ASTM A276
Invert seals and compression load pad	Neoprene or EPDM, ASTM D2000 60 Durometer
Side Seal	Ultra-High Molecular Weight (UHMW) Polymer, ASTM D4020
Top Wedges (if needed)	ASTM A351-CF8N, Type 304 or 316
Pedestals, Wall Brackets and Stem Guide Brackets	ASTM A240, Type 304L
Stem Guide Bushings	Silicon Bronze, ASTM B584, Alloy 873 or UHMW Polymer, ASTM D4020
Anchors	ASTM F593/D594, Alloy Group 1 or 2, or ASTM A276

NOTE: EPDM or Neoprene to be used only as a flush bottom seal on upward-opening gates.

- C. Components

1. Operators shall be of the type indicated in the Slide Gate Schedule or on the Contract Drawings.
2. Slide Gate shall have square or rectangular openings as specified in the Schedule provided on the Contract Drawings.

2.3 SLIDE GATES (STAINLESS STEEL)

- A. All stainless steel slide gates shall comply with AWWA C561.

2.4 SLIDE GATES (ALUMINUM)

- A. All aluminum slide gates shall comply with AWWA C562.
- B. The guides shall be of extruded aluminum incorporating a single slot. The guides shall be designed for maximum rigidity, shall have a weight of not less than 4 lbs. per foot and will be provided with keyways to lock it into the concrete. The invert of the frame shall be a structural member welded to the lower ends of the guides to form a flush bottom invert. The invert seals shall be mounted to the frame.
- C. Where the guides extend above the operating floor, they shall be sufficiently strong so that no further reinforcing will be required. The yoke to support the operating bench stand will be formed by two C channels welded at the top of the guides to provide a one-piece rigid frame. The arrangement of the yoke shall be such that the disc and stem can be removed without disconnecting the yoke.
- D. The disc or sliding member shall be of aluminum plate reinforced with aluminum extrusions welded to the plate not more than 16 inches apart. An invert seal shall be attached to the invert member of the frame to provide a flush bottom gate configuration. Surface shall be minimum 3/4" and the seal shall be mechanically fastened to the gate frame. Invert seals that are press fit or that use adhesives shall not be acceptable.
- E. All structural parts of the gate, slide and frame, below the operating floor shall have a minimum thickness of 1/4".
- F. All aluminum in contact with concrete shall be field coated by the Contractor with a heavy coat of a suitable bituminous paint.

2.5 COMPONENTS

- A. Operators shall be of the type indicated in the Slide Gate Schedule or on the Drawings.
- B. Slide gates shall have square or rectangular openings as specified. They shall be rising stem type unless noted otherwise.

2.6 FRAMES

- A. Furnish flange back frames for all wall mounted gates. Gate seats, seals and frame shall be an integral unit. Frames shall be provided with lifting lugs.

- B. Frames shall be rectangular flanged frames to connect with wall thimbles or be face mounted and provide for openings of the shape and dimensions specified unless otherwise indicated.
- C. The frame shall be an integral unit of structural shapes, rigidly assembled to form the waterway opening. The frame members shall form guides for the slide, and holes shall be provided for mounting on anchor bolts. The head channels shall be welded to the gate frame. The head channels are to be sufficiently spaced to allow removal of the gate slide. The primary slot of the frame shall contain polymer guide bars to prevent metal-to-metal contact between slide and frame.

2.7 GUIDES

- A. The guides shall be constructed from formed plate. Wall mounted guides shall have a minimum weight of 13 lbs. per foot. The portion of the wall mounted guide that the anchor penetrates shall have a minimum thickness of 1/2-inch.
- B. Embedded frames, frames to mount in existing channels and guide extensions shall have a minimum weight of 6.5 lbs. per foot. The guides shall be sufficiently long to retain at least two thirds of the vertical dimension of the slide when fully open. Seals shall be replicable without removing the gate from the embedment.
- C. Guides shall be faced with ultra-high molecular weight polymer (UHMWPE) with an intrinsic viscosity of not less than 14 and a low coefficient of friction. The UHMWPE seals shall be self-adjusting. Side wedges and pressure pads are not acceptable. Neoprene seals that come in direct contact with the friction surfaces are not acceptable.
- D. All seats and seals shall be mechanically fastened with 316 stainless steel attachment bolts and shall be field replaceable without the need to remove the frame from the wall or without the need to remove grout or concrete.

2.8 YOKES

- A. Furnish a yoke on self-contained gates that consists of two C-channels of sufficient dimensions to withstand loads developed during gate operation. Channels shall have a minimum depth of four (4) inches. Provide a stainless steel adaptor plate with a minimum thickness of 1/2-inch for mounting the operating mechanism.

2.9 SLIDE

- A. Fabricate gate slide of one-quarter inch thick plate, reinforced with structural shapes to limit deflection under full head to less than 1/360 of span or 1/16-inch, whichever is less. The portion of the slide that engages the frame shall have a minimum thickness of 1/2-inch. The slide shall engage the frame a minimum of 1-inch on each side. Weld stem pocket or stem connectors to the slide and make capable of withstanding full thrust developed during gate operation. The connection between the slide and stem shall be made by a minimum of two bolts.

2.10 SEALS

- A. Provide upward opening gates so designated with a solid EPDM or neoprene seal attached to the bottom cross member of the frame, flush with the invert. Attach seal with stainless steel attachment bolts and/or a stainless steel retainer, seal replaceable without disassembly of the gate.
- B. Slide gates shall incorporate a flush-bottom seal that is attached to the bottom frame invert member. Seals attached to the slide are not acceptable.
- C. Self-adjusting, UV stabilized UHMW seals shall be provided on the sides of the opening utilizing a rubber compression pad or cord to allow for self-adjusting once installed. UHMW sealing surfaces to be extruded, not saw cut, to ensure smooth surface finish. Top member seal shall be sufficiently flexible to self-adjust, using compression cord or pad, with deflection in the slide plate under unseating loads.
- D. All seats and seals shall be mechanically fastened with 316 stainless steel attachment bolts and shall be field replaceable without the need to remove the frame from the wall or without the need to remove grout or concrete.

2.11 WEIR GATES

- A. Downward opening slide gates shall be as specified above except they shall open downward. Provide self-adjusting UHMWPE seals at bottom and sides, securely held in place by stainless steel attachment bolts and/or stainless steel retainers. Neoprene seals that come in direct contact with the friction surfaces are not acceptable.

2.12 STEMS

- A. Gate stem diameter shall be 1-1/2 inches minimum. Stems shall be adequate to withstand twice the force created by a 80-lb pull on the hand-wheel or crank. Stems shall have full depth, Acme rolled threads with a maximum roughness of 16 micro-inches. Cut threads are not acceptable. The stem shall be supported by integral stem guide angles or wall mounted brackets with bronze split type stem collars, spaced to provide an 1/r ratio of 200 or less. Stems shall withstand 1.25 times the stalled motor thrust of the actuator.

2.13 ACCESSORIES

- A. Anchors
 - 1. Anchors shall be furnished by the gate manufacturer. Furnish one-piece anchor of ASTM A276, 316 stainless steel. Anchors shall have a minimum diameter of 1/2-inch.
- B. Fabricate stems from round stainless steel bars. Threaded portion of stem shall have machine rolled, full depth Acme threads polished to a 16 micro inch finish or better. Stem shall be threaded and pinned to a bronze nut in the slide pocket or bolted to the stainless steel stem connector.

- C. Supply fully adjustable stem guides, UHMWPE or bronze bushed, fabricated stainless steel stem guides, spaced as recommended by the gate manufacturer, to hold stem in alignment, but allow easy operation. However, length to radius of gyration shall not exceed 200. Stem guides for self-contained gates shall, if required, be structural angles welded or bolted to the frame to accommodate the stem.
- D. Fabricate all fasteners including anchor bolts of 316 stainless steel. Provide anchor bolts with washers and two nuts each. Design lift mechanisms to operate with no more than a 40 pound pull on the handwheel or crank at maximum operating head. The maximum radius of the handwheel shall be 24 inches or 15 inches for hand cranks. Self-contained gates with manual operators shall have ductile iron lift housing mounted on the yoke. A bronze lift nut, supported by ball thrust or roller bearings, flanged to maintain position in the housing shall accommodate the maximum thrust developed during opening and closing. Lift shall include an internally threaded bronze stop nut above the lift nut to prevent over closing of the gate. Provide lifts for non-self contained gates with a fabricated stainless steel pedestal, ductile iron gear housing and internally threaded bronze stop nut. Flanged lift nut shall be bronze, provided with ball thrust or roller bearings above and below the flange. Gears shall be machined with cut teeth and bronze sleeve bearings.

2.14 LIFT ASSEMBLIES

- A. Floor stands shall be of the enclosed gear pedestal or yoke mounted lift type with single or double gears as required, and with thrust bearings above and below the flange on the bronze lifting nut. Floor stands and wall brackets fabricated of 304L 316L stainless steel. Bevel and pinion gears shall be steel with cut teeth. Bearings for the gear and pinion shaft shall be ball thrust or roller type. The lift shall operate on a 40-lb pull on the handwheel or crank at design head. A clear butyrate plastic pipe stem cover shall be provided with Mylar open and close position indication.
- B. The guides on self-contained gates shall extend above the operating floor. They shall be sufficiently strong so that additional reinforcing is not necessary. The yoke to support the operating benchstand will be formed by welding two channels across the top of the guides.
- C. Where the head frame extends higher than 5 ft. above the operating floor, the gate operator shall include a remote bevel gear assembly to lower the operator centerline to approximately 36-inches above the operating floor.
- D. Gate Operator
 - 1. General:
 - a. Operation of the gate shall be by means of a manual handwheel operated gearbox or crank operated gearbox, or electric motor operator mounted on the yoke of the gate as shown on the Drawings, Gate Schedule. Manual operators shall be provided with an input shaft that is suitable for operation with a portable operator.
 - b. The manual benchstand shall be fully enclosed, equipped with ball thrust or roller bearings above and below the bronze operating nut and with a mechanical seal around the operating nut. On a handwheel and crank operated benchstand, the pinion shaft shall be stainless steel and supported on ball thrust or roller bearings.

- c. A mechanical seal shall be provided around the pinion shaft where it extends from the hoist enclosure.
 - d. The operating stem shall be of Type 304 stainless steel designed to have a slenderness ration (L/R) of less than 200, to withstand at least twice the rated output of the benchstand and to have a minimum diameter of 1-1/2".
2. Electric Gate Operator:
- a. The operator shall be the helical and worm gear type driven by electric motor. All power gearing shall be grease or oil lubricated. The valve manufacturer shall furnish the value of the maximum operating torque required to operate the valve in accordance with the latest revision of AWWA C542 standard. The operator manufacturer shall furnish evidence that the operator is designed to equal or exceed the torque requirements.
 - b. Unless otherwise noted, the operator shall be geared to operate the gate at a rate of approximately 12 in. in 60 seconds under the full specified operating head. It shall be possible to change this cycle time by substituting suitable gear trains. The operator shall be equipped with a declutchable handwheel for manual operation. The operator shall be designed to hold the valve in any intermediate position between fully open and fully closed without creeping or fluttering.
 - c. Suitable reduction gearing shall be provided off the main shaft of the gearing, turning approximately 270 degrees while the valve performs full travel. The reduction gearing shall be equipped with a mechanical position indicator dial. Other indicating devices shall be provided as indicated.
 - d. Each operator shall be equipped with adjustable torque switches for overload protection in both opening and closing directions with torque switch bypass for unseating.
 - e. Each operator shall be equipped with four adjustable train gear limit switches. Each limit switch shall include a switch and counter gear. The setting accuracy shall be less than 1/10 turn of the operator output shaft. Two (2) gear limit switches are for switching off when reaching end positions.
 - f. Each motor shall be 480 volts, 60 Hz, three phase, squirrel cage, totally enclosed type suitable for open-close or modulating service as required. The motor shall be capable of starting and stopping with a frequency of 10 cycles per minute and of reversing service after a minimum delay of 50 msec.
 - g. Three (3) thermostats in series placed in the winding shall provide the motor with thermal protection. They shall interrupt the control circuit as soon as the temperature goes beyond the permissible winding temperature.
 - h. Each operator shall be equipped with a reversing magnetic starter. The starter shall be capable of receiving contact closures from remote sources to actuate the operator in either direction. Control voltage shall be 120 volts supplied by a transformer included in the control enclosure. Each operator shall include a local OPEN-STOP- CLOSE control switch and a pad lockable LOCAL-OFF- REMOTE selector switch.
 - i. All electrical components shall be integral with the operator, housed in a watertight enclosure suitable for Class 1 Division 1 environment or a NEMA 4X enclosure as required.
 - j. A circuit-breaker disconnect shall be provided with the operator.

- k. Provide operator with two dry contacts, prewired to the common terminal block, for monitoring of gate status. One shall indicate gate open position and the other gate closed.
- l. Easily identifiable terminal blocks shall be provided for all external power, control, and signal connections.
- m. Operator, located outdoors, shall include thermostats and space heaters in the motor and control compartments as needed and heavy duty butyrate stern covers.
- n. The operator shall be as manufactured by:
 - 1) Auma
 - 2) Limitorque
 - 3) Rotork
 - 4) Or approved equal.

2.15 PAINTING AND FINISHING

- A. Stainless steel gates and accessories shall not be painted.
- B. All weld burn and spatter on stainless steel components shall be passivated by the manufacturer in accordance with ASTM A380. If bead blasting or sand blasting is used for passivation, the entire slide and frame shall be blasted to a uniform finish.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install the work of this Section in strict accordance with the manufacturer's recommendations and shop drawings as approved by the Engineer.
- B. Installation shall be as shown on the Drawings and in conformance with the latest revision of AWWA C561 and AWWA Standard C542 where appropriate.
- C. Upon completion of the installation, carefully inspect each component and verify that all items have been installed in their proper location, adequately anchored, and adjusted to achieve optimum operation.

3.2 TESTING

- A. After installation the Contractor shall test each gate for satisfactory operation and watertightness against maximum operating pressure insofar as practicable.
- B. Leakage limits shall be as follows:
 - 1. For stainless steel and aluminum gates maximum leakage shall not exceed 0.05 US gal/min/ft. for seating and unseating heads.

3.3 OPERATION AND MAINTENANCE MANUALS

- A. Prior to or with the delivery of equipment, the manufacturer shall provide copies of an operation and maintenance manual including storage, installation, start-up, operating and maintenance instructions and a complete parts list and recommended spare parts list. The O & M manuals shall be in compliance with the General Requirements.
- B. Demonstrate to the Owner's operation and maintenance personnel the proper methods for operating and maintaining the equipment, and the contents of the operation and maintenance manual required to be submitted under Article 1.5 in this Section.
- C. A field service technician, employed by the gate manufacturer, shall visit the project site after installation of the equipment. Two (2) separate trips of one (1) day each is required. The Contractor shall furnish to the Owner, through the Engineer, a written report prepared by the equipment manufacturer's field service technician certifying that the equipment:
 - 1. Has been properly installed and lubricated.
 - 2. Is in accurate alignment.
 - 3. Is free from any undue stress imposed by connecting piping or anchor bolts.
 - 4. Has been operated under full load and that it operates satisfactorily and in compliance with the requirements of this Section.

END OF SECTION 352226

SECTION 400507 - PROCESS PIPE HANGERS AND SUPPORTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawing and general provisions of the Contract, including the General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes hangers and supports for process piping systems and equipment.
- B. Related Sections: The following Sections contain requirements that relate to this Section:
 - 1. Division 5 Section "Metal Fabrications" for materials for attaching hangers and supports to building structure.

1.3 DEFINITIONS

- A. MSS: Manufacturers Standardization Society for the Valve and Fittings Industry.
- B. Terminology: As defined in MSS SP-90, "Guidelines on Terminology for Pipe Hangers and Supports."

1.4 PERFORMANCE REQUIREMENTS

- A. Design channel support systems for piping to support multiple pipes capable of supporting combined weight of supported systems, system contents, and test water.
- B. Design heavy-duty steel trapeze for piping to support multiple pipes capable of supporting combined weight of supported systems, system contents, and test water.

1.5 SUBMITTALS

- A. General: Submit the following according to the Conditions of the Contract and Division 1 Specification Sections.
- B. Product Data: For each type of pipe hanger, channel support system component, and thermal-hanger shield insert indicated.
- C. Shop Drawings shall be signed and sealed by a qualified professional engineer for multiple piping supports and trapeze hangers. Include design calculations and indicate size and characteristics of components and fabrication details. Shop drawings for each type of hanger and support, indicating dimensions, weights, required clearances, and methods of component assembly.
- D. Submit pipe hanger and support schedule showing manufacturer's Figure No., size, location, and features for each required pipe hanger and support.

1.6 QUALITY ASSURANCE

- A. Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
- B. Engineering Responsibility: Design and preparation of Shop Drawings and calculations for each multiple pipe support and trapeze by a qualified professional engineer.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified:
 - 1. Pipe Hangers:
 - a. AAA Technology and Specialties Co., Inc.
 - b. B-Line Systems, Inc.
 - c. Carpenter & Patterson, Inc.
 - d. Empire Tool & Manufacturing Co., Inc.
 - e. Globe Pipe Hanger Products, Inc.
 - f. Grinnell Corp.
 - g. GS Metals Corp.
 - h. Michigan Hanger Co., Inc.
 - i. National Pipe Hanger Corp.
 - j. PHD Manufacturing, Inc.
 - k. PHS Industries, Inc.
 - l. Piping Technology & Products, Inc.
 - 2. Channel Support Systems:
 - a. B-Line Systems, Inc.
 - b. Grinnell Corp.; Power-Strut Unit.
 - c. GS Metals Corp.
 - d. Michigan Hanger Co., Inc.; O-Strut Div.
 - e. National Pipe Hanger Corp.
 - f. Thomas & Betts Corp.
 - g. Unistrut Corp.
 - h. Wesanco, Inc.
 - 3. Thermal-Hanger Shield Inserts:
 - a. Carpenter & Patterson, Inc.
 - b. Michigan Hanger Co., Inc.
 - c. PHS Industries, Inc.
 - d. Pipe Shields, Inc.
 - e. Rilco Manufacturing Co., Inc.
 - f. Value Engineered Products, Inc.
 - 4. Powder-Actuated Fastener Systems:
 - a. Gunnebo Fastening Corp.
 - b. Hilti, Inc.
 - c. ITW Ramset/Red Head.

- d. Masterset Fastening Systems, Inc.

2.2 MANUFACTURED UNITS

- A. Pipe Hangers, Supports, and Components: MSS SP-58, factory-fabricated components. Refer to "Hanger and Support Applications" Article in Part 3 for where to use specific hanger and support types.
 - 1. General:
 - a. Interior hangers, rods, supports, etc. to be corrosion resistant, hot dipped galvanized steel.
 - b. Exterior hangers, rods, supports, etc. to be corrosion resistant, Type 304 or 316 stainless steel.
 - 2. Nonmetallic Coatings: On attachments for electrolytic protection where attachments are in direct contact with copper tubing.
 - 3. All attachments to precast hollow-core concrete slabs shall comply with slab manufacturer's installation instructions.
- B. Channel Support Systems: MFMA-2, factory-fabricated components for field assembly.
 - 1. Coatings: Manufacturer's standard finish unless bare metal surfaces are indicated.
 - 2. Nonmetallic Coatings: On attachments for electrolytic protection where attachments are in direct contact with copper tubing.
- C. Thermal-Hanger Shield Inserts: 100-psi minimum compressive-strength insulation, encased in sheet metal shield.
 - 1. Material for Cold Piping: ASTM C 552, Type I cellular glass or water-repellent-treated, ASTM C 533, Type I calcium silicate with vapor barrier.
 - 2. Material for Cold Piping: ASTM C 552, Type I cellular glass with vapor barrier.
 - 3. Material for Cold Piping: Water-repellent-treated, ASTM C 533, Type I calcium silicate with vapor barrier.
 - 4. Material for Hot Piping: ASTM C 552, Type I cellular glass or water-repellent-treated, ASTM C 533, Type I calcium silicate.
 - 5. Material for Hot Piping: ASTM C 552, Type I cellular glass.
 - 6. Material for Hot Piping: Water-repellent-treated, ASTM C 533, Type I calcium silicate.
 - 7. For Trapeze or Clamped System: Insert and shield cover entire circumference of pipe.
 - 8. For Clevis or Band Hanger: Insert and shield cover lower 180 degrees of pipe.
 - 9. Insert Length: Extend 2 inches beyond sheet metal shield for piping operating below ambient air temperature.

2.3 MISCELLANEOUS MATERIALS

- A. Powder-Actuated Drive-Pin Fasteners: Powder-actuated-type, drive-pin attachments with pull-out and shear capacities appropriate for supported loads and building materials where used.
- B. Mechanical-Anchor Fasteners: Insert-type attachments with pull-out and shear capacities appropriate for supported loads and building materials where used.
- C. Structural Steel: ASTM A 36/A 36M, steel plates, shapes, and bars, black and galvanized.
- D. Grout: ASTM C1107, Grade B, factory-mixed and -packaged, non-shrink and nonmetallic, dry, hydraulic-cement grout.
 - 1. Characteristics: Post hardening and volume adjusting; recommended for both interior and exterior applications.
 - 2. Properties: Non-staining, noncorrosive, and nongaseous.
 - 3. Design Mix: 5000-psi, 28-day compressive strength.

PART 3 - EXECUTION

3.1 HANGER AND SUPPORT APPLICATION

- A. General: Interior hangers, rods, supports, etc. to be corrosion resistant, hot dipped galvanized steel. Exterior hangers, rods, supports, etc. to be corrosion resistant, Type 304 or 316 stainless steel.
- B. All attachments to precast hollow-core concrete slabs shall comply with slab manufacturer's installation instructions.
- C. Specific hanger requirements are specified in Sections specifying equipment and systems.
- D. Comply with MSS SP-69 for pipe hanger selections and applications that are not specified in piping specification Sections.
- E. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Specification Sections, install the following types:
 - 1. Adjustable Steel Clevis Hangers (MSS Type 1): For suspension of non-insulated or insulated stationary pipes, NPS 1/2 to NPS 30.
 - 2. Yoke-Type Pipe Clamps (MSS Type 2): For suspension of 120 to 450-deg F pipes, NPS 4 to NPS 16, requiring up to 4 inches of insulation.
 - 3. Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes, NPS 3/4 to NPS 24, requiring clamp flexibility and up to 4 inches of insulation.
 - 4. Steel Pipe Clamps (MSS Type 4): For suspension of cold and hot pipes, NPS 1/2 to NPS 24, if little or no insulation is required.

5. Pipe Hangers (MSS Type 5): For suspension of pipes, NPS 1/2 to NPS 4, to allow off-center closure for hanger installation before pipe erection.
6. Adjustable Swivel Split- or Solid-Ring Hangers (MSS Type 6): For suspension of non-insulated stationary pipes, NPS 3/4 to NPS 8.
7. Adjustable Steel Band Hangers (MSS Type 7): For suspension of non-insulated stationary pipes, NPS 1/2 to NPS 8.
8. Adjustable Band Hangers (MSS Type 9): For suspension of non-insulated stationary pipes, NPS 1/2 to NPS 8.
9. Adjustable Swivel-Ring Band Hangers (MSS Type 10): For suspension of non-insulated stationary pipes, NPS 1/2 to NPS 2.
10. Split Pipe-Ring with or without Turnbuckle-Adjustment Hangers (MSS Type 11): For suspension of non-insulated stationary pipes, NPS 3/8 to NPS 8.
11. Extension Hinged or Two-Bolt Split Pipe Clamps (MSS Type 12): For suspension of non-insulated stationary pipes, NPS 3/8 to NPS 3.
12. U-Bolts (MSS Type 24): For support of heavy pipe, NPS 1/2 to NPS 30.
13. Clips (MSS Type 26): For support of insulated pipes not subject to expansion or contraction.
14. Pipe Saddle Supports (MSS Type 36): For support of pipes, NPS 4 to NPS 36, with steel pipe base stanchion support and cast-iron floor flange.
15. Pipe Stanchion Saddles (MSS Type 37): For support of pipes, NPS 4 to NPS 36, with steel pipe base stanchion support and cast-iron floor flange and with U-bolt to retain pipe.
16. Adjustable Pipe Saddle Supports (MSS Type 38): For stanchion-type support for pipes, NPS 2-1/2 to NPS 36, if vertical adjustment is required, with steel pipe base stanchion support and cast-iron floor flange.
17. Single Pipe Rolls (MSS Type 41): For suspension of pipes, NPS 1 to NPS 30, from two rods if longitudinal movement caused by expansion and contraction might occur.
18. Adjustable Roller Hangers (MSS Type 43): For suspension of pipes, NPS 2-1/2 to NPS 20, from single rod if horizontal movement caused by expansion and contraction might occur.
19. Complete Pipe Rolls (MSS Type 44): For support of pipes, NPS 2 to NPS 42, if longitudinal movement caused by expansion and contraction might occur but vertical adjustment is not necessary.
20. Pipe Roll and Plate Units (MSS Type 45): For support of pipes, NPS 2 to NPS 24, if small horizontal movement caused by expansion and contraction might occur and vertical adjustment is not necessary.
21. Adjustable Pipe Roll and Base Units (MSS Type 46): For support of pipes, NPS 2 to NPS 30, if vertical and lateral adjustment during installation might be required in addition to expansion and contraction.

- F. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Specification Sections, install the following types:
1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers, NPS 3/4 to NPS 20.
 2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers, NPS 3/4 to NPS 20, if longer ends are required for riser clamps.
- G. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Specification Sections, install the following types:
1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches for heavy loads.
 2. Steel Clevises (MSS Type 14): For 120 to 450-deg F piping installations.
 3. Swivel Turnbuckles (MSS Type 15): For use with MSS Type 11, split pipe rings.
 4. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.
 5. Steel Weldless Eye Nuts (MSS Type 17): For 120 to 450-deg F piping installations.
- H. Building Attachments: Unless otherwise indicated and except as specified in piping system Specification Sections, install the following types:
1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
 2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joist construction to attach to top flange of structural shape.
 3. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
 4. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
 5. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
 6. C-Clamps (MSS Type 23): For structural shapes.
 7. Top-Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge.
 8. Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.
 9. Steel-Beam Clamps with Eye Nuts (MSS Type 28): For attaching to bottom of steel I-beams for heavy loads.
 10. Linked-Steel Clamps with Eye Nuts (MSS Type 29): For attaching to bottom of steel I-beams for heavy loads, with link extensions.
 11. Malleable Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.
 12. Welded-Steel Brackets: For support of pipes from below or for suspending from above by using clip and rod. Use one of the following for indicated loads:
 - a. Light (MSS Type 31): 750 lb.

- b. Medium (MSS Type 32): 1500 lb.
 - c. Heavy (MSS Type 33): 3000 lb.
13. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
 14. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.
 15. Horizontal Travelers (MSS Type 58): For supporting piping systems subject to linear horizontal movement where head room is limited.
- I. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Specification Sections, install the following types:
1. Steel Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
 2. Protection Shields (MSS Type 40): Of length recommended by manufacturer to prevent crushing insulation.
 3. Thermal-Hanger Shield Inserts: For supporting insulated pipe, 360-degree insert of high-density, 100-psi minimum compressive-strength, water-repellent-treated calcium silicate or cellular-glass pipe insulation, same thickness as adjoining insulation with vapor barrier and encased in 360-degree sheet metal shield.
- J. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system Specification Sections, install the following types:
1. Restraint-Control Devices (MSS Type 47): Where indicated to control piping movement.
 2. Spring Cushions (MSS Type 48): For light loads if vertical movement does not exceed 1-1/4 inches.
 3. Spring-Cushion Roll Hangers (MSS Type 49): For equipping Type 41 roll hanger with springs.
 4. Spring Sway Braces (MSS Type 50): To retard sway, shock, vibration, or thermal expansion in piping systems.
 5. Variable-Spring Hangers (MSS Type 51): Preset to indicated load and limit variability factor to 25 percent to absorb expansion and contraction of piping system from hanger.
 6. Variable-Spring Base Supports (MSS Type 52): Preset to indicated load and limit variability factor to 25 percent to absorb expansion and contraction of piping system from base support.
 7. Variable-Spring Trapeze Hangers (MSS Type 53): Preset to indicated load and limit variability factor to 25 percent to absorb expansion and contraction of piping system from trapeze support.
 8. Constant Supports: For critical piping stress and if necessary to avoid transfer of stress from one support to another support, critical terminal, or connected equipment. Include auxiliary stops for erection, hydrostatic test, and load-adjustment capability. These supports include the following types:
 - a. Horizontal (MSS Type 54): Mounted horizontally.

- b. Vertical (MSS Type 55): Mounted vertically.
- c. Trapeze (MSS Type 56): Two vertical-type supports and one trapeze member.

3.2 HANGER AND SUPPORT INSTALLATION

- A. Pipe Hanger and Support Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from building structure.
- B. Channel Support System Installation: Arrange for grouping of parallel runs of piping and support together on field-assembled channel systems.
 - 1. Field assemble and install according to manufacturer's written instructions.
- C. Heavy-Duty Steel Trapeze Installation: Arrange for grouping of parallel runs of horizontal piping and support together on field-fabricated, heavy-duty trapezes.
 - 1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified above for individual pipe hangers.
 - 2. Field fabricate from ASTM A 36/A 36M, steel shapes selected for loads being supported. Weld steel according to AWS D-1.1.
- D. Install building attachments within concrete slabs or attach to structural steel. Space attachments within maximum piping span length indicated in MSS SP-69. Install additional attachments at concentrated loads, including valves, flanges, guides, strainers, and expansion joints, and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.
- E. Install powder-actuated drive-pin fasteners in concrete after concrete is placed and completely cured. Use operators that are licensed by powder-actuated tool manufacturer. Install fasteners according to powder-actuated tool manufacturer's operating manual.
- F. Install mechanical-anchor fasteners in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.
- G. Install hangers and supports complete with necessary inserts, bolts, rods, nuts, washers, and other accessories.
- H. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.
- I. All piping shall be adequately supported and braced by means of adequate hangers, concrete piers, pipe supports, brackets, or as otherwise shown on the plan or recommended by the pipe and equipment manufacturer requirements. No pipe support shall fall on a pipe joint. Contactor shall provide unions and flexible couplers (not shown on plans) to provide adequate removal of valves and equipment.

- J. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.
- K. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and so maximum pipe deflections allowed by ASME B31.9, "Building Services Piping," is not exceeded.
- L. Insulated Piping: Comply with the following:
 - 1. Attach clamps and spacers to piping.
 - a. Piping Operating above Ambient Air Temperature: Clamp may project through insulation.
 - b. Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.
 - c. Do not exceed pipe stress limits according to ASME B31.9.
 - 2. Install MSS SP-58, Type 39 protection saddles, if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.
 - a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.
 - 3. Install MSS SP-58, Type 40 protective shields on cold piping with vapor barrier. Shields shall span arc of 180 degrees.
 - a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.
 - 4. Shield Dimensions for Pipe: Not less than the following:
 - a. NPS 1/4 to NPS 3-1/2: 12 inches long and 0.048 inch thick.
 - b. NPS 4: 12 inches long and 0.06 inch thick.
 - c. NPS 5 and NPS 6: 18 inches long and 0.06 inch thick.
 - d. NPS 8 to NPS 14: 24 inches long and 0.075 inch thick.
 - 5. Insert Material: Length at least as long as protective shield.
 - 6. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

3.3 EQUIPMENT SUPPORTS

- A. Fabricate structural steel stands to suspend equipment from structure above or support equipment above floor.
- B. Grouting: Place grout under supports for equipment and make a smooth bearing surface.

3.4 METAL FABRICATION

- A. Cut, drill, and fit miscellaneous metal fabrications for pipe and equipment supports.
- B. Fit exposed connections together to form hairline joints. Field-weld connections that cannot be shop-welded because of shipping size limitations.

- C. Field Welding: Comply with AWS D1.1 procedures for manual shielded metal-arc welding, appearance and quality of welds, methods used in correcting welding work, and the following:
 - 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
 - 2. Obtain fusion without undercut or overlap.
 - 3. Remove welding flux immediately.
 - 4. Finish welds at exposed connections so that no roughness shows after finishing, and so that contours of welded surfaces match adjacent contours.

3.5 ADJUSTING

- A. Hanger Adjustment: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.

3.6 PAINTING

- A. Touching Up: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
 - 1. Apply paint by brush or spray to provide a minimum dry film thickness of 2.0 mils.
- B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

END OF SECTION 400507

SECTION 400523 - PROCESS VALVES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes materials, equipment, appurtenances, operators, and incidentals required for process valves and miscellaneous fittings, as shown and specified. Work includes all types of valves and miscellaneous fittings required for buried, exposed, submerged, and other types of piping except where otherwise specifically included in other Sections.
- B. Extent of each type of size of valve required is indicated on drawings and/or schedule.
- C. All valves used for a particular service are to be of the same manufacturer, make and style for each valve type.
- D. Each valve unit shall be of the proper size and type to suit the intended service with appropriate; body style, operator, joint accessories, coatings, guides, supports, pertinent accessories to be complete, in placed, tested and ready for service in conformance with project conditions.

1.3 SUBMITTALS

- A. General: Submit the following in accordance with conditions of Contract and Division 1 Specification Sections.
- B. Product Data: Provide manufacturer's illustrated catalog data depicting general construction, materials list, coatings and necessary appurtenances in sufficient detail to verify product compliance.
- C. Shop Drawings: Provide manufacturer's drawings showing; principal dimensions, operator detail and arrangements, project schedule tag reference or location of intended usage as required to suit project conditions.

1.4 QUALITY ASSURANCE

- A. Supply valves and appurtenances that are standard product in regular production by manufacturer whose products have proven reliable in similar service for at least three (3) years.
- B. All valves used for a particular service are to be of the same manufacturer, make and style for each valve type.
- C. All shaft couplings and mounting plates shall be coordinated by, approved by, and warranted by the valve manufacturer.

- D. Each valve shall be subjected to operation and hydrostatic tests at the manufacturer's plant as specified within applicable AWWA Standards.
- E. All coated surfaces shall receive manufacturer's production and holiday testing as specified in applicable AWWA Standards.

1.5 DELIVERY, STORAGE AND HANDLING

- A. Preparation for Transport: Prepare valves for shipping as follows:
 - 1. Ensure valves are dry and internally protected against rust and corrosion.
 - 2. Protect valve ends against damage and entry of dirt, etc. by use of appropriate end protectors.
 - 3. Set valves in best position for handling. Set gate valves closed to prevent rattling; set ball and plug valves open to minimize exposure of functional surfaces; set butterfly valves closed or slightly open; and block swing check valves in either closed or open position.
- B. Storage: Use the following precautions during storage:
 - 1. Do not remove valve end protectors unless necessary for inspection; then reinstall for storage.
 - 2. Protect valves from weather. Store valves indoors. Maintain valve temperature higher than the ambient dew point temperature. If outdoor storage is necessary, support valves off the ground or pavement in watertight enclosures.
- C. Handling: Use a sling to handle valve whose size requires handling by crane or lift. Rig valves to avoid damage to exposed or internal valve parts. Do not use handwheels and stems as lifting or rigging points.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Manufacturer's Name and Working Pressure: Cast information in raised letters on valve body.
- B. Valves bodies shall be of either gray or ductile cast iron.
- C. Valves shall have non-rising stems, open by turning left or counter-clockwise and be provided with either a 2-inch square nut for buried valves or handwheel for exposed valves unless otherwise noted. The direction of opening shall be indicated by an arrow cast on the body and/or the actuator.
- D. All body bolts and nuts shall be bronze or stainless steel for buried, submerged or non-protected applications and cadmium plated for exposed or interior applications that will receive protective finish coatings.

2.2 VALVES

- A. The valves, described in this section shall be resilient seated gate valves manufactured to meet or exceed AWWA C509. Valves shall be of compression type seal design, providing bubble tight shut-off with bi-directional seating ability for pressures up to 200 psi.
- B. The valve shall have a smooth, unobstructed waterway free from any sedimentation pockets. Valve shall provide a 100% port of nominal pipe size when fully open. Tapping valve port shall be sized to permit a full pipe port tap.
- C. Body style shall be mechanical joint type for buried service, flange joint type for exposed service and when required, to include special end connections for tapping requirements or otherwise if indicated on the contract drawings.
- D. Stuffing boxes shall be O-ring seal type with two (2) rings located in steam above thrust collar.
- E. Thrust bearings shall be of the low friction torque reduction type, located both above and below the steam collar.
- F. Valves shall be as manufactured by:
 - 1. American Flow Control,
 - 2. Clow
 - 3. M & H
 - 4. Mueller, U.S. Pipe
 - 5. Or an approved equal.

2.3 BUTTERFLY VALVES - AIR

- A. Valves utilized shall be specifically designed for air service and 25 psi air pressure.
- B. Butterfly valves shall meet the intent of the latest AWWA Specification C504, Class 25. These valves shall be a AWWA C606 grooved ends, fully lugged wafer type, or a flanged type design as indicated on the contract drawings; with ductile iron body, ASTM A536, Grade 65-45-12, or cast iron body, ASTM A126, Class B.
- C. Disc to be ductile iron, ASTM A536, Grade 65-45-12 with electroless nickel plating or solid welded on nickel disc edge.
- D. Elastomer seats shall be in the body. Seat on disc edge is not acceptable in air systems. Seats shall be of EPDM, and be field replaceable without special tools. Elastomer thickness, not inclusive of backing rings or stiffeners, shall be a minimum of 3/8-inch for valves 6 inches and smaller; and 1/2-inch for valves 8 inches and larger.
- E. Shafts shall be of 304 stainless steel construction. Shaft seals shall be adjustable chevron packing or O-ring.
- F. Discharge butterfly valves shall have locking lever operators.
- G. Valves shall be as manufactured by: DeZurik, Mueller, Pratt or an approved equal.

2.4 BUTTERFLY VALVES – WATER

- A. Butterfly valves shall comply with the latest revision of AWWA Specification C504, Class 150B. Valve discs shall be ductile iron, one (1) piece cast design for constant drip tight closure with flow in either direction for pressure up to 150 psi.
- B. Body style shall be full bodied, mechanical joint for buried service and flange joint type for exposed service unless otherwise indicated on the contract drawings.
- C. Wafer or lug body styles, when called for, shall have body applied seats that totally encapsulate the inside surface of the valve and also serve as the flange gaskets.
- D. All valve seat mating surfaces shall be against a 304 stainless steel disc edge surface for body applied seats.
- E. Full body style valve seats shall be of Buna-N (Nitrile) rubber applied to either the body:
 - 1. Body applied seats shall be retained by a bonding process meeting ASTM-D-429, Test Method "B" or may be mechanically retained.
- F. Shafts shall be 316 or 304 stainless steel construction. Shaft bearings shall be self-lubricated sleeve type. Shaft seals may be of V-type packing or standard O-ring seals allowing replacement without removing the valve shaft.
- G. Valves shall be as manufactured by: DeZurik, Mueller, Pratt or an approved equal.

2.5 CHECK VALVES – WATER

- A. Swing Check: Valves shall be quiet closing and constructed for a minimum of 150 pounds working pressure. They shall be iron body, stainless steel body seats, with outside lever and adjustable weights and have hinge pins of stainless steel.
- B. Valves shall be as manufactured by: Valves shall be a product of: Clow, GA, APCO, or an approved equal.
- C. Air Cushioned Swing Check: Valves shall be GA Industries Model 250-D cushioned swing check valves with outside lever and weight, APCO, or an approved equivalent. Cushioned check valves shall be installed in the locations noted.
- D. Valves shall be in full compliance with the latest revision of AWWA Specification C508.

2.6 GATE OR TAPPING VALVES

- A. The valves, described in this section shall be resilient seated gate valves manufactured to meet or exceed AWWA C509. Valves shall be of compression type seal design, providing bubble tight shut-off with bi-directional seating ability for pressures up to 200 psi.
- B. The valve shall have a smooth, unobstructed waterway free from any sedimentation pockets. Valve shall provide a 100% port of nominal pipe size when fully open. Tapping valve port shall be sized to permit a full pipe port tap.

- C. Body style shall be mechanical joint type for buried service, flange joint type for exposed service and when required, to include special end connections for tapping requirements or otherwise if indicated on the contract drawings.
- D. Stuffing boxes shall be O-ring seal type with two (2) rings located in steam above thrust collar.
- E. Thrust bearings shall be of the low friction torque reduction type, located both above and below the steam collar.

2.7 KNIFE GATE VALVES

- A. Knife gate valves shall be wafer style with tapped bolt holes, one (1) piece body design, and suitable for 0 to 150 psig drip-tight shut-off service. Valves over 20 inches in diameter shall be suitable for 50 psig rating.
- B. Valve, bodies, blade, stem, and all other wetted parts shall be 304 stainless steel. The gate shall have a rounded bottom with 45-degree beveled knife edge and all sides of gate should be finish ground.
- C. Valves shall have handwheel with rising stem and rated for service pressures. Valves over 20 inches in diameter shall be bevel gear operated.
- D. Flanges shall be drilled to ANSI B 16.1, CL 125, 150 psi standard.
- E. Grooved ends complying with AWWA C606 for steel piping.
- F. Valve packing shall be suitable material, multiple V-ring, compression type with a definite packing gland coated with plastic or epoxy to prevent corrosion.
- G. The yoke sleeve shall be acid resisting bronze.
- H. Provide neoprene elastomer seat ring.
- I. Valves shall be the product of DeZurik, Model KGC-HD or an approved equal.

2.8 MUD VALVES

- A. Valves shall be of the rising stem type unless otherwise noted. The operating mechanism shall be as shown on the Contract Drawings.
- B. The valve body shall be flanged and drilled to ANSI B 16.1, CL 125, 150 psi standard.
- C. The stem, frame, cover and wall bracket shall be ASTM A240, Type 304 stainless steel. The stem nut shall be bronze.
- D. Extension stems, operator, stem supports, floor box, etc. shall be provided as required by specifications, Valve Schedule and/or shown on the drawings.
- E. Valve shall be as manufactured by: RW Gate, Clow, Trumbull, Troy Valve or an approved equal.

2.9 PLUG VALVES

- A. Valves shall be the non-lubricated, eccentric type with resilient, soft faced Buna-N rubber plugs providing bi-directional dead-tight shut-off to the full valve rating. Valve pressure ratings shall be 175 psi through 12-inches and 150 psi for valves over 12 inches.
- B. Bodies of valves shall be furnished with a welded overlay seat of not less than 90% pure nickel. Seat area shall be completely covered with raised surface weld to insure that the plug face contacts only nickel. Screwed-in seats shall not be acceptable.
- C. Plugs shall be of ASTM A126 Class B cast iron or elastomer coated ductile iron ASTM A536 Grade 65-45-12. The plug shall have a cylindrical seating surface eccentrically offset from the center of the plug shaft. The interference between the plug face and body seat shall be externally adjustable in the field with valve in line under pressure. Round shaped ports are not acceptable.
- D. Valve bearings shall be sleeve type, oil impregnated, permanently lubricated, stainless steel. Nonmetallic bearings shall not be acceptable.
- E. Shaft seals may be of the multiple V-ring and shall be externally adjustable and replaceable without removing the valve or actuator while under pressure.
- F. Plug Valves 4-inch and above shall be equipped with the gear and handwheel.
- G. Valves shall be as manufactured by: DeZurik, or an approved equal.

2.10 PRESSURE RELIEF VALVES - AIR

- A. The pressure relief valves shall be compatible with the operating conditions of the blowers as defined elsewhere in these specifications. Each of the blowers shall be furnished with a weighted pressure relief valve on the discharge as shown on the drawings.
- B. The weight loaded pressure relief valve shall be cast iron body with cast iron weights. The cast iron weights shall be easily added or subtracted so that an adjustment can be made to accommodate the blower's pressure capabilities.
- C. The weighted pressure relief valves shall be as manufactured by: Fuller Company, Roots Type PW, or an approved equal.

2.11 PRESSURE RELIEF VALVES - WATER; TANK TYPE

- A. Valves to be of floor and wall type as required to suit project conditions. All such valves are to be of same manufacturer throughout project and installed per published recommendations of such.
- B. Valves shall be of flanged body style and be complete with body, or wall, pipe in length of concrete thickness being placed, removable strainer and soft composition rubber seats on both the body and cover.
- C. Floor types have integral locking lugs to retain cover, but allow for removable if necessary.

- D. Wall types shall be hinged with bronze pin and may permit use of an independent wall casting if strainer is mounted within the valve unit.
- E. Valves shall be as manufactured by American Flow Control, Clow, Trumbull Industries or an approved equal.

2.12 TELESCOPING VALVES

- A. Valves shall be capable of giving an infinitely variable discharge rate to suit travel range as indicated on the drawings.
- B. Valves shall be of the rising stem type, unless otherwise noted.
- C. General Contractor shall provide normal bolted, cast iron flange at elevation shown on the drawing and shall be responsible to provide sufficient straight pipe below the valve to allow for full travel of the tube inside.
- D. Each valve shall consist of an offset cast iron floor stand with suitable stem guide, cut tooth pinion bar rack assembly, spur gear with ductile iron locking panel, clear plastic stem cover with cap and travel scale indicator. Pinion shaft is operated by a 12-inch diameter offset handwheel with a rotating crank handle, or an 18-inch diameter top mounted handwheel with anti-rotation plate as required by valve schedule and/or plan illustration.
- E. The decant tube is to be of PVC pipe, smooth, stiff, concentric, connected on upper end with stainless steel bail and threaded adjustable rod connected to the bar rack assembly.
- F. Special flange having a neoprene O-ring insert and a flange transition seal gasket shall be provided by the equipment manufacturer to bolt to pipe flange by Contractor. Foundation bolts for operating stand will be stainless steel furnished with the equipment.
- G. Valves shall be as manufactured by FMC Corporation, Waterman Industries or an approved equal.

2.13 FLAP GATES/TIDE GATES

- A. Unless otherwise indicated, flap gates/tide gates shall be as follows:
 - 1. Flap valves shall have a flanged cast iron frame and flap with bronze seats having heavy duty cast iron double hinge arms with stainless steel hinge pins.
 - 2. All gates shall be fully automatic, operating solely by differences in pressure on both sides of the valve. Each valve shall be adjustable so as to provide the optimum opening and yet close providing a virtually watertight seal when no seating head is present.
 - 3. The flap gate shall be secured to a flanged wall casting or thimble connection unless otherwise indicated. Wall thimbles, when needed, shall be a one-piece design supplied by the flap gate manufacturer.
 - 4. Valves shall be as manufactured by Hydro-Gate, Rodney Hunt, RW Gate Company, Golden Harvest, Fontaine or an approved equal.

2.14 OPERATORS

- A. All valves 6 inches and larger, and all buried, submerged, or chain operated valves shall be gear operated. Gears for valve operation shall be sized for the working pressure and installed in such a manner that the stuffing box will be accessible for packing.
- B. Manual Operation
1. Valves shall be equipped with nut, handwheel, crank, chain, gears, floor stand, and other appurtenances as required for manual operation as specified or scheduled.
 2. Operation shall be designed so that the effort required to operate the handwheel, lever, or chain shall not exceed 25 lbs. applied at the extremity of the wheel or lever.
 3. Handwheels on valves 4 in. and larger shall not be less than 12 in. in diameter.
 4. Chainwheels shall be provided when installed centerline of valve is over 5 ft.-6 in. above the floor. Chains shall be cadmium plated and loop 3 ft.-6 in. from the floor. Orient chainwheel and provide intermediate pulley mounting, if necessary, to permit unobstructed chain operation.
 5. Wrench nuts shall be cast iron or bronze, 1-15/16 in. at top, 2 in. square at base and 1-3/4 in. high with a flanged base.
 - a. Provide one (1) tee wrench for each valve type used and of each significant length differential required. All wrenches supplied shall be a length so that the bar handle extends approximately 3 feet above finished grade in addition to the required bury depth length(s).
- C. Electric Valve Operations
1. The operator shall be the helical and worm gear type driven by an electric motor. All power gearing shall be grease lubricated. The actuator shall be in conformance with AWWA C540. The valve manufacturer shall furnish the value of the maximum operating torque required to operate the valve as defined in the Appendix to AWWA C540. The operator manufacturer shall furnish evidence that the operator is designed to equal or exceed the torque requirements.
 2. Unless otherwise noted, the operator shall be geared to operate the valve from the fully open position to the fully closed position or vice-versa in approximately 60 seconds. It shall be possible to change this cycle time by substituting suitable gear trains. The operator shall be equipped with a declutchable handwheel for manual operation. The operator shall be designed to hold the valve in any intermediate position between fully open and fully closed without creeping or fluttering.
 3. Suitable reduction gearing shall be provided off the main shaft of the gearing, turning approximately 270 degrees while the valve performs full travel. The reduction gearing shall be equipped with the following position indicating devices for each operator:
 - a. A mechanical position indicator dial;
 - b. The output signal shall be 4-20 ma; a standard potentiometer, 1000 ohms with linearity of +/- 3% for indication in the remote controller;
 4. Each operator shall be equipped with adjustable torque switches for overload protection in both opening and closing directions with torque switch bypass for unseating.
 5. Each operator shall be equipped with four adjustable train gear limit switches. Each limit switch shall include a switch and counter gear. The setting accuracy shall be less than 1/10 turn of the operator output shaft. Two (2) gear limit switches are for remote indication of end positions.

6. Each motor shall be 480 volts, 60 Hz, three phase, induction type as recommended by the operator manufacturer.
7. Three (3) thermostats in series placed in the winding shall provide the motor with thermal protection. They shall interrupt the control circuit as soon as the temperature goes beyond the permissible winding temperature.
8. Each operator shall be equipped with a reversing magnetic starter. The starter shall be capable of receiving contact closures from remote sources to actuate the operator in either direction. Control voltage shall be 120 volts supplied by a transformer included in the control enclosure. Each operator shall include a local OPEN-STOP-CLOSE control, push button station, and a pad lockable LOCAL-OFF-REMOTE selector switch.
9. All electrical components shall be integral with the operator, housed in a watertight NEMA 4X enclosure and completely wired.
10. A circuit-breaker disconnect shall be provided with the operator.
11. Easily identifiable terminal blocks shall be provided for all external power, control, and signal connections.
12. Operators, located outdoors, shall include thermostats and space heaters in the motor and control compartments.
13. The operator shall be as manufactured by Rotork, Limitorque, EIM, Auma or equal.

2.15 PROTECTIVE COATINGS

- A. All iron parts of valve assemblies shall be painted before leaving the shop.
- B. All exterior and internal waterway ferrous surfaces of each valve, except finished or bearing surfaces shall be shop painted with a liquid or powder epoxy coating of approximately 10 mils dry film thickness conforming to AWWA C-550.

2.16 EXTENSION STEMS AND STEM GUIDES

- A. When required by drawings, schedule or project details, provide an extension stem made of cold-rolled steel material and the same size as the stem of the valve it operates. If the extension is more than 8 ft. long, intermediate stem guides shall be installed and supported from the wall by suitable brackets at a maximum spacing of 8 ft.
- B. Brackets and stem guides shall be made of cast iron and fully adjustable. The guide block shall be bronze bushed where it contacts the extension stem. Stem guides shall be as manufactured by the Eddy Valve Co., Rodney Hunt, or equal. Secure stem guides to walls with stainless steel bolts. In the event of off-set or misalignment, provide off-set extension rod with universal end fittings at valve actuator and stem drop connection.
- C. Extension stem shall have connecting socket for 2-inch square nut and pin socket to lock on valve operating nut.

2.17 VALVE BOXES

- A. Valve boxes shall be cast iron, 5-1/4" shaft, three-piece screw type, adjustable boxes. The top section to have a drop lid of which to be marked for service which it is used cast thereon. Cover and boxes shall be round pattern.
- B. Provide proper base size and shape to straddle the valve bonnet without touching or being supported by the valve mechanism. Use No. 6 base size for 6-inch and 8-inch gate valves or typical butterfly valve operators, No. 160 oval base size for 12-inch and larger gate valves or other size necessary to suit a particular valve manufacturer's requirements.
- C. Extension sections shall be provided where the depth of trench is such that they are needed to bring the top of the box to finished grade. The valve box shall be installed so that it is perfectly vertical and centered on the valve operating nut.

2.18 FLOOR BOXES AND STANDS

- A. Each valve operator projecting through a floor shall be equipped with a floor box or floor stand and extension stem.
- B. Floor boxes for access to operating nuts of valves, sluice or slide gates shall be cast iron cover and body with bronze or brass bushings. Casting length to equal the thickness of the concrete slab in as much as possible. Floor boxes shall be as manufactured by Clow, Trumbull Industries or an approved equivalent.
- C. Floor stands shall be made of cast iron and shall extend to a level where handwheel or other operator is easily operated. Stands shall be fitted with bronze bushings to maintain proper stem alignment, brass or stainless steel nameplates shall be provided to identify related valve manufacturer, valve type and size or in the case of stand being of valve manufacturer, cast in name would suffice. Provide plastic stem covers with open-close scale for all rising stem applications. Stands shall be anchored to the concrete slab with stainless steel bolts.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Valves shall be carefully handled and placed so as not to permit any damage to the interior coatings, disc or seat. Internal type lifting devices shall not be permitted. Do not use handwheels or stems as lifting or rigging points.
- B. All valves shall be carefully installed in their respective positions free from distortion and stress. Connecting joints shall conform to applicable requirements of the specifications.
- C. Stem guides shall be accurately aligned.
- D. If the valve box is tipped or otherwise not centered on the valve operating nut or not installed at the proper elevation, the Contractor shall, at his own expense, make whatever correction is required to remedy the defect promptly, upon notice to do so by the Engineer.

3.2 TESTING

- A. All valves shall be tested in place by the Contractor as far as practicable under conditions for the pipelines in which they are placed, and defects revealed in valves or connections under test shall be corrected at the expense of the Contractor to the satisfaction of the Engineer.

3.3 OPERATION AND MAINTENANCE MANUALS

- A. Prior to or with the delivery of equipment, the manufacturer shall provide copies of an operation and maintenance manual including storage, installation, start-up, operating and maintaining instructions, and a complete parts and recommended spare parts list. The O & M Manuals shall be in compliance with the General Requirements of these specifications.

END OF SECTION 400523

SECTION 402336 - PIPES AND PIPE FITTINGS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Divisions 1– 46 Specification sections, apply to work of this section.

1.2 DESCRIPTION OF WORK

- A. CONTRACTOR shall provide all labor, materials, equipment, and incidentals as shown, specified, and required to furnish all process pipes and fittings.
- B. Exposed and buried process piping:
 - 1. Extent of piping is shown on the Drawings and Piping Schedule, specify pipe service, diameter, material, lining, coating, pressure rating, joint type, and testing required.
- C. Coordination:
 - 1. Review installation procedures under this and other Sections and coordinate installation of items to be installed with or before ductile iron pipe Work.
- D. Interior and exterior process piping.
- E. Piping associated with the following processes chemical feed piping.
- F. All PVC and CPVC pipe and fittings shall be manufactured in the U.S.A.

1.3 QUALITY ASSURANCE

- A. General: All materials shall be free from defects impairing strength and durability and be of the best quality for the purposes specified or shown on the Drawings. It shall have structural properties sufficient to solely sustain or withstand strain and stresses to which it is normally subjected and be true to detail.
- B. Manufacturer's Qualifications:
 - 1. Firms regularly engaged in manufacturer of pipes and pipe fittings of types and sizes required, whose products have been in satisfactory use in similar service for not less than 5 years.
 - 2. Provide piping and appurtenances that are the standard product in regular production by Manufacturers whose products have proven reliable in similar service for at least two years.
 - 3. Provide piping and appurtenances of the same type from a single manufacturer.
 - 4. All castings used for coupling housings, fittings, and valve bodies shall be date stamped for quality assurance and traceability.
 - 5. Ductile iron pipe manufacturer shall be responsible for all products and all factory-applied linings and coatings, whether installed at pipe manufacturer's facility or at manufacturer's Supplier's facility.

6. All grooved joint couplings, fittings, valves, and specialties shall be the products of a single manufacturer. Grooving tools shall be of the same manufacturer as the grooved components.
- C. Regulatory Requirements:
 1. Pipe and fittings, including linings and coatings, that will convey potable water or water that will be treated to become potable, shall be certified by an accredited organization in accordance with NSF/ANSI 61 as being suitable for contact with potable water, and shall comply with requirements of authorities having jurisdiction at Site.
- D. Testing:
 1. Manufacturer's certified test results as defined for the type of pipe shall be stamped approved by the Contractor and forwarded to the Engineer as a Reference Submittal. No pipe shall be installed which does not meet the requirements of these Specifications.
- E. All pipe, joints, and fittings shall be pressure tested as required by this Specification for the type of pipe. The Contractor shall notify the Engineer or Owner, in writing, at least 48 hours prior to performing the tests.
- F. Codes and Standards
 1. Welding: Quality welding procedures, welders and operators in accordance with ASME B31.1, or ASME B31.9, as applicable, for shop and project site welding of piping work.
 - a. Certify welding of piping work using Standard Procedure Specifications by, and welders tested under supervision of, the National Certified Pipe Welding Bureau (NCPWB).
 2. Brazing: Certify brazing procedures, brazers, and operators in accordance with ASME Boiler and Pressure Vessel Code, Section IX, for shop and job-site brazing of piping work.
 3. NSF Labels: Where plastic piping is indicated to transport potable water, provide pipe and fittings bearing approval label by National Sanitation Foundation (NSF).
- G. The Contractor shall be responsible for making all field measurements prior to installation of his work. Any deviations in measurements between the field conditions and the Drawings shall be immediately reported to the Engineer.

1.4 SUBMITTALS

- A. Provide technical submittals in accordance with Division 01 Section "Submittal Procedures", demonstrating piping and accessories conform completely to the requirements of this Section.
- B. Product Data:
 1. Submit manufacturer's technical product data, installation instructions, and dimensioned drawings for each type of pipe and pipe fitting.
 2. Submit piping schedule showing Manufacturer, pipe diameter, pipe or tube weight, wall thicknesses, fitting type, and joint type and accessories for each piping system.
 3. Support and anchor details with manufacturer's maximum recommended loads.
 4. Design calculations indicating support spacing requirements for all size pipe.
 5. Grooved joint products shall be shown on drawings and product submittals shall be specifically identified with the applicable Victaulic style or series number.
- C. Shop Drawings

1. Detailed drawings and data for pipe, fittings, gaskets, appurtenances, linings (for DIP), and coatings (for DIP).
 2. Complete piping layout indicating type of pipe, diameter and location. Show dimensions from adjacent structure, equipment and other piping.
 3. Location of all pipe joints, sleeves, valves, and couplings.
 4. Location of all pipe supports and anchors.
 5. Details of pipe anchors, supports, couplings, and joints.
 6. Grooved joint couplings and fittings may be shown on drawings and product submittals, and shall be specifically identified by the manufacturer's style or series designation.
- D. Informational Submittals: Submit the following:
- E. Testing: Copies of all field test reports.
- F. Contractor shall verify chemical compatibility of piping, solvents, gaskets, seals, o-rings, etc. for each chemical feed system. Provide chemical compatibility charts and manufacturer's written verification of compatibility for each chemical feed system.
- G. Welding Certifications: Submit reports as required for piping work.
- H. Brazing Certifications: Submit reports as required for piping work.
- I. Maintenance Data: Submit maintenance data and parts lists for each type of mechanical fitting. Include this data, product data, and certifications in maintenance manual; in accordance with requirements of Division 1.
- 1.5 DELIVERY, STORAGE, AND HANDLING:
- A. Handling, delivery, and storage shall be in accordance with the manufacturer's recommendations.
1. In no case shall the pipe or appurtenance be dumped, dropped, or thrown.
 2. Interiors of piping shall be completely free of dirt and foreign matter.
- B. Protect flanges and fittings from moisture and dirt by inside storage and enclosure, or by packing with durable, waterproof wrapping.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Piping Materials: Provide pipe and tube of type, joint type, grade, size and weight (wall thickness or Class) indicated for each service. Where type, grade or class is not indicated, provide proper selection as determined by Installer for installation requirements, and comply with governing regulations and industry standards.
- B. All standard and special ductile iron castings shall conform to the latest applicable AWWA and/or ANSI specifications for pressure fittings with end conditions as specified herein. AWWA C110 (ANSI A21.10) shall be applicable for all ductile iron fittings.

- C. Pipe/Tube Fittings: Provide factory-fabricated fittings of type, materials, grade, class and pressure rating indicated for each service and pipe size. Provide sizes and types matching pipe, tube, valve or equipment connection in each case. Where not otherwise indicated, comply with governing regulations and industry standards for selections, and with pipe manufacturer's recommendations where applicable.
- D. The outside of all piping, valves, and fittings shall bear the Manufacturer's standard marking for type, pressure, etc.
- E. All pipe and fittings shall be equal to or better than the grade specified.
- F. Whenever Specifications call for close bending or coiling, use Grade B pipe.
- G. All piping material shall be new and free from defects and shall be subject to standard mill test before being shipped. No salvaged or used pipe shall be used.
- H. Fittings shall have the Manufacturer's name or trademark legibly raised or cut into each piece, and shall bear the Manufacturer's standard marking for type, pressure, etc.
- I. All pipe shall be cut off even and reamed full bore. Threads shall be cut smooth, true and to full standard size. Piping shall be installed clean of chips, burrs or oil.
- J. Victaulic grooved fittings and couplings and valves may be utilized in lieu of welded, threaded, or flanged joints as shown on the Drawings. Gasket selection and intended use shall be verified as suitable for the intended service as published in the manufacturer's latest literature. Installation shall be in accordance with the coupling manufacturer's latest published instructions.

2.2 DUCTILE IRON PIPE (DIP OR DI)

- A. Pipe
 - 1. Standards
 - a. Flanged: ANSI/AWWA C115/A21.15.
 - b. Non-flanged: ANSI/AWWA C151/A21.51.
 - c. Thickness: If not otherwise specified, use Class 53 for three-inch to 54-inch diameter pipe and Pressure Class 350 for 60-inch and 64-inch diameter pipe.
 - d. Lining: Cement-mortar lining, ANSI/AWWA C104/A21.4.
 - e. Grooved end pipe shall be Class 53 (min), with ends that comply with ANSI / AWWA C606.
 - 2. Coating
 - a. Buried pipe: 1 mil asphalt coating, AWWA C151.
 - b. Exposed pipe to be painted: Factory prime coat compatible with finished coat system.
- B. Joints
 - 1. As shown on the Drawings. If not designated, use grooved or flanged joints for exposed piping and restrained joints for buried piping.
 - 2. Flanged
 - a. Ductile iron, ANSI A21.10.
 - b. Bolt Circles and Bolt Holes: Class 125.
 - c. Gaskets: 1/8 inch EPDM full faced.
 - d. Bolts and nuts.

- 1) Buried and exposed: 304 stainless steel bolts, 304 stainless steel nuts.
- 2) Submerged: Type 316 stainless steel.
3. Grooved joint couplings shall consist of two or more ductile iron housings to ASTM A536, FlushSeal pressure responsive gasket to ASTM D2000, and zinc-electroplated steel bolts and nuts to ASTM A449. Basis of Design: Victaulic Style 31.
4. Mechanical or Push-on
 - a. ANSI A21.11.
 - b. Gaskets: plain tipped.
 - c. Bolts and nuts: 304 stainless steel bolts, 304 stainless steel nuts.
5. Restrained
 - a. Use restrained joints for all exterior, buried, ductile iron process pipe.
 - b. Restraining wedges shall be made of ductile iron; conform to ASTM A536.
 - c. Where restrained joints are required for fittings only, provide a full length of pipe on both sides of the fitting.
 - d. Manufacturers
 - 1) Megalug by EBAA Iron Sales.
 - 2) TR Flex or FIELD LOK by US Pipe.
 - 3) Super-Lock or Restrained Tyton Joint by Clow.
 - 4) Flex-Ring or Lok-Ring by American Cast Iron Pipe Company.
 - 5) Or equal.

C. Fittings

1. Types: Flanged, grooved or mechanical, as indicated on Drawings.
2. Flanged: ANSI/AWWA C110/A21.10.
3. Grooved end fittings shall comply with ANSI A21.10 /AWWA C110 for center to end dimensions, and ANSI A21.10 /AWWA C110 or AWWA C153 for wall thickness, with ends to AWWA C606. Basis of Design: Victaulic AWWA Fittings.
4. Grooved joint couplings shall consist of two or more ductile iron housings to ASTM A536, FlushSeal pressure responsive gasket to ASTM D2000, and zinc-electroplated steel bolts and nuts to ASTM A449. Basis of Design: Victaulic Style 31.
5. Mechanical joint
 - a. 3 inches -16 inches: Full body ANSI/AWWA C110/A21.10 or short body ANSI/AWWA C153/A21.53.
 - b. Larger than 16 inches: Full body ANSI/AWWA C110/A21.10.
6. Pressure rating: 250 psi minimum.
7. Coating and lining: Identical to connecting piping.
8. Base tees and bends: Drill and furnish with anchor bolts. Machine when used as pipe kicker.

D. Polyethylene Encasement

1. Conform to ANSI/AWWA A21.5/C-106.
2. 8 mil black virgin polyethylene.
3. Wrap all ductile iron pipe and fittings.

2.3 PVC PIPE AND FITTINGS

- A. Pipe: Pipe shall be Schedule 80, Type I, Grade I (Class 12454-B) conforming to ASTM D 1784 and D 1785.
- B. Nipples: Short nipples shall be the same as the PVC pipe.

- C. Fittings: Fittings shall be schedule 80 and shall conform to ASTM D 2464 for threaded fittings 6-inches and smaller and ASTM D 2467 for socket-type fittings 8-inches and smaller. For threaded fittings larger than 6-inches and for solvent welded fittings larger than 8-inches the fittings shall be schedule 80 per the manufacturer's standards. All fittings shall successfully pass the required pressure test.
 - D. Flanges: PVC flanges shall be made of the same material as the pipe. Flanges shall match the bolt pattern of ANSI B16.5, Class 150. Flanges shall be flat face.
 - E. Unions
 - 1. Unions shall have socket-type ends, EPDM o-rings, and shall be schedule 80. Material shall be Type 1, Grade I PVC, cell class 12454, per ASTM D 1784.
 - 2. Provide Unions at connections to equipment, valves, and other accessories to facilitate equipment removal.
 - F. Joints
 - 1. Pipe and fitting joints shall be socket welded except where grooved, threaded and flanged joints are required to connect to unions, valves, and equipment
 - 2. Screwed joints that are necessary to match up to threaded valves or fittings shall be made up with Teflon Tape only.
 - 3. Flanged joints shall be made with solvent welded PVC flanges.
 - G. Solvent Cement: IPS Corporation Weld-On 724 without exception unless the Contractor provides certification from the pipe and cement supplier that a superior type of cement is available for the application.
 - H. Gaskets for flanges: Shall be PROCO Series 9013 or equal based on chemical compatibility.
 - I. Bolts and Nuts for Flanges
 - 1. Bolts: Type 316 stainless steel conforming to ASTM A 193, Grade B8M
 - 2. Nuts: silicon-bronze
 - 3. Provide a washer under each nut and under each bolthead. Washers shall be of the same material as the bolts.
 - 4. Lubricant shall be TRX-Synlube by Ramco, Anti-Seize by Ramco, Husk-It Husky Lube O'Seal, or equal
 - J. Threaded ends: Taper pipe threads. All threaded female fittings shall be 316 stainless steel reinforced.
 - K. Manufacturer
 - 1. Pipe: Harvel or equal.
 - 2. Fittings: Spears or equal.
- 2.4 CPVC
- A. Rigid CPVC pipe shall be Schedule 80, Type IV, Grade I. Compound used in the manufacture of the pipe and fittings shall conform to ASTM D1784, Cell Class 23447. The compound shall contain the specified amounts of pigment, stabilizers and other additives approved by the National Sanitation Foundation (NSF) for the conveyance of potable water. Pipe dimensions shall be in accordance with ASTM F-441.

- B. Nipples: short nipples shall be the same as the CPVC pipe.
 - C. Fittings: All fittings shall be schedule 80 injection molded CPVC, cell classification 23447, conforming to ASTM D1784. Fittings shall be listed for potable water service by NSF and manufactured in strict compliance to ASTM F 437 for threaded fittings, and ASTM F 439 for socket type.
 - D. Flanges: CPVC flanges shall be made of the same material as the pipe. Flanges shall match the bolt pattern of ANSI B16.5, Class 150. Flanges shall be flat face.
 - E. Unions
 - 1. Unions shall have socket-type ends and shall be schedule 80. Material shall be Type IV, Grade 1 CPVC, cell class 23447, per ASTM D1784.
 - 2. O-rings: For all systems, check chemical compatibility.
 - 3. Provide Unions at connections to equipment, valves, and other accessories to facilitate equipment removal.
 - F. Joints
 - 1. Pipe and fitting joints shall be socket welded except where grooved, threaded and flanged joints are required to connect to unions, valves, and equipment.
 - 2. Screwed joints that are necessary to match up to threaded valves or fittings shall be made up with Teflon Tape only.
 - 3. Flanged joints shall be made with solvent welded CPVC flanges.
 - G. Solvent Cement: IPS Corporation Weld-On 724 without exception
 - H. Gaskets for flanges shall be of the following materials:
 - 1. Shall be Proco Series 9013 or equal low torque gasket based on chemical compatibility.
 - 2. Shall be Proco Series 9013 or equal low torque gasket based on chemical compatibility.
 - I. Bolts and Nuts for Flanges
 - 1. Bolts: Type 316 stainless steel conforming to ASTM A 193, Grade B8M.
 - 2. Nuts: silicon-bronze.
 - 3. Provide a washer under each nut and under each bolthead. Washers shall be of the same material as the bolts.
 - 4. Lubricant shall be TRX-Synlube by Ramco, Anti-Seize by Ramco, Husk-It Husky Lube O'Seal, or equal.
 - J. Threaded joints: Taper pipe threads. All threaded female fittings shall be 316 stainless steel reinforced.
 - K. Manufacturer:
 - 1. Pipe: Harvel or equal.
 - 2. Fittings: Spears or equal.
- 2.5 POLYPROPYLENE PIPE (PP)

- A. Pipe shall be extruded from Group 1, Class 2, Alpha nucleated homopolymer material in accordance with ASTM D-4101. AP polypropylene resin shall achieve a minimum tensile strength of 300 bar when tested at 23 deg C according to ASTM D 638.
- B. Material shall allow continuous operating temperatures to 95 deg C. AP resin shall comply with relevant food substance regulation, US FDA guidelines as specified in Code of Federal Regulators (CFR), Title 21, Chapter 1: Section 177.1520 and Section 178.3297 suitable for contact with foodstuff, pharmaceutical use and potable water.
- C. Pipe shall be stress relieved by post-extrusion annealing to eliminate inherent stresses in the pipe wall created by the extrusion process.
- D. System (pipe and fittings) shall be pressure rated in accordance with ASTM D-2837 and Din 8077 for hydrostatic design basis. Pipe shall be manufactured to an SDR (standard dimension ratio) in order to provide the same pressure rating in all diameters.
- E. Pipe shall be SDR 11 series that defines the wall thickness and outer diameter of the pipe.
- F. All pressure pattern fittings (elbows, tees, flanges and reducers) from 1/2" (20 mm) through 16" (400 mm) shall be injection molded and shall have the same pressure rating as the pipe.
- G. Socket fusion fittings dimension are in accordance with ISO 7279 and DIN 16962. Butt fusion conform to SDR (standard dimension ratio) series that defines the wall thickness and outer diameter.
- H. All pressure fitting 1/2" (20 mm) through 4" (110 mm) shall be socket fusion type joints. Pressure fittings, drainage pattern fittings and pipe 2" and larger shall be joined by butt fusion welding. All fusion-welded joints to be performed in accordance with ASTM D-2657 and piping manufacturers recommendations.
- I. Installer shall have a paid certification by the manufacturer. Only certified installers shall install and weld pipe.
- J. Gaskets: PTFE film low torque PROCO - 9013 (www.procoproducts.com). Gasket shall be full faced, low torque, fully molded EPDM with dual concentric, convex sealing rings and PTFE film bonded to the rubber. The dimensions shall comply with 150# ANSI B16.5 drilling. Chemical compatibility shall be confirmed.
- K. Bolts and Nuts for Flanges
- L. Bolts: Type 316 stainless steel conforming to ASTM A 193, Grade B8M
- M. Pipe shall be Simtech, SIMTECH 877-777-2467 (www.SimtechUSA.com), or Approved equal.

2.6 PVDF (KYNAR) PIPE

- A. System (pipe and fittings) shall be pressure rated in accordance with ASTM D-2837. Pipe shall be manufactured to an SDR (standard dimension ratio) in order to provide the same pressure rating in all diameters. Pipe shall be:

$$SDR 21 *PN16 (3/8" - 4") = 232 \text{ psi}$$

** PN = Nominal pressure rating in bar*

- B. Materials: Pipe shall be extruded from virgin, pure, unpigmented homopolymer KYNAR 740® resin, as manufactured by Atofina Chemicals, Inc. Material shall meet or exceed requirements of Table 1 of ASTM D-3222. Pipe manufacturing shall not employ any stabilizers, antioxidants, fillers, pigmentation or additives of any kind.
- C. Pipe shall be stress relieved by post-extrusion annealing to eliminate inherent stresses in the pipe wall created by the extrusion process.
- D. All pipe and fittings shall comply with the dimensions and tolerances outlined in ASTM D3261. Pipe shall have a 2.5 safety factor for a 50-year life. Pipe shall be furnished in 16.4 feet length.
- E. All pressure pattern fittings (elbows, tees, flanges and reducers) from 3/8 inch through 4 inch shall be injection molded and shall have the same pressure rating as the pipe. Fittings shall not contain any stabilizer, antioxidants, fillers, pigmentation or additives of any kind. All fittings shall have a 2.5 safety factor for a 50-year life.
- F. All pressure fitting 3/8 inch through 4 inch shall be an interference fit socket fusion type joint. All fusion weld joints to be performed in accordance with ASTM D-2657-87 and piping manufacturers recommendations. Welder certificates, certifying that welders comply with the installation procedures as outlined by ASTM D-2657. All training should be scheduled and completed prior to job start-up.
- G. Gaskets: PTFE film low torque PROCO - 9013 (www.procoproducts.com). Gasket shall be full faced, low torque, fully molded EPDM with dual concentric, convex sealing rings and PTFE film bonded to the rubber. The dimensions shall comply with 150# ANSI B16.5 drilling. Chemical compatibility shall be confirmed.
- H. Bolts and Nuts for Flanges
 1. Bolts: Type 316 stainless steel conforming to ASTM A 193, Grade B8M.
 2. Nuts: Silicon-bronze.
 3. Provide a washer under each nut and under each bolthead. Washers shall be of the same material as the bolts.
 4. Lubricant shall be TRX-Synlube by Ramco, Anti-Seize by Ramco, Husk-It Husky Lube O'Seal, or equal.
- I. Markings: all pipe and fittings shall be clearly marked with the manufacturer's name or trademark, size, and country of manufacture.
- J. Installer shall have a paid certification by the manufacturer. Only certified installers shall install and weld pipe.
- K. Manufacturer: All pipe, fittings & valves shall be SIMTECH (Phone: 877-777-2467) www.simtechUSA.com, or Engineer-approved equal

2.7 HIGH DENSITY POLYETHYLENE PRESSURE PIPE (HDPE) AND FITTINGS

- A. Materials: PE3408 High Density Polyethylene (HDPE), ASTM D3350 cell classification 345444C.

- B. The material shall have a minimum Hydrostatic Design Basis (HDB) of 1600 psi at 73 degrees F when tested in accordance with PPI TR-3 and shall be listed in the name of the pipe and fitting manufacturer in PPI TR-4.
- C. NSF Approval: The material used in the production of the greenstripe pipe is not required to have NSF approval. Use greenstripe pipe for the raw water piping and where shown on the drawings.
- D. Pipe
 - 1. HDPE pipe shall be manufactured in accordance with AWWA C901 for sizes 1/2-inch through 3-inch and AWWA C906 for sizes 4-inch and larger.
 - 2. Pipe shall be supplied in Ductile Iron Pipe (DIP) sizes.
 - 3. The pipe supplied shall be designed for the following working conditions, but shall be a minimum of DR 17:
 - a. Working Pressure: 75 psi.
 - b. Dead Load: 8 feet of ground cover, silty sand and gravel.
 - c. Live Load: H-20.
 - 4. Permanent identification of piping service shall be provided by co-extruding longitudinal blue or green stripes into the pipe's outside surface. The striping material shall be the same material as the pipe except for the color.
- E. Fittings
 - 1. HDPE fittings shall be made from material meeting the same requirements as the pipe. Fittings shall be molded or fabricated by the manufacturer of the pipe.
 - 2. Where applicable, fittings shall meet the requirements of AWWA C906.
 - 3. Molded fittings shall be manufactured in accordance with either ASTM D2683 (socket fused) or ASTM D3261 (butt fused) and shall be marked accordingly.
 - 4. Fittings shall be butt-fused to the piping unless otherwise noted.
- F. Quality Control
 - 1. The pipe and fitting manufacturer shall have an established quality control program responsible for inspecting incoming and outgoing materials. Incoming polyethylene materials shall be inspected for density, melt flow rate, and contamination. The cell classification properties of the material shall be certified by the supplier. Incoming materials shall be approved by Quality Control before processing into finished goods. Outgoing products shall be tested as required in AWWA C901 or C906.
 - 2. The Manufacturer shall maintain permanent Quality Control and Quality Assurance records. Certification or copy of these records shall be made available upon request.
 - 3. The Manufacturer shall have manufacturing and quality control facilities capable of producing and assuring the quality of the pipe and fittings required by these specifications. Given reasonable notice, the Manufacturer's production facilities shall be open for inspection by the Owner or Engineer.
- G. Installation and Testing
 - 1. The Manufacturer shall supply an Installation Manual to the Engineer and Contractor which outlines guidelines for handling, joining, installing, embedding and testing of HDPE pipeline.
 - 2. Joints between plain ends of HDPE pipe shall be made by butt fusion. The pipe manufacturer's fusion procedures shall be followed at all times. The wall thicknesses of the adjoining pipes shall have the same DR at the point of fusion.

3. When mechanical fittings are utilized for transitions between pipe materials, connections to valves, and other locations, the recommendation of the mechanical fitting or valve manufacturer shall be followed. At a minimum, all mechanical joints shall be installed with a mechanical joint restrainer with 316 stainless steel pipe stiffeners. All mechanical joint materials and joining methods shall be approved and/or recommended by the HDPE pipe manufacturer.
4. On each day butt fusions are to be made, the first fusion of the day shall be a trial fusion. The trial fusion shall be allowed to cool completely, then fusion test straps shall be cut out. The test strap shall be 12-inches or 30-times the wall thickness in length (minimum) and 1-inch or 1.5-times the wall thickness in width (minimum). Bend the test strap until the ends of the strap touch. If the fusion fails at the joint, a new trial fusion shall be made, cooled completely and tested. Butt fusion of pipe to be installed shall not commence until a trial fusion has passed the bent strap test.
5. Pressure testing shall be conducted in accordance with the Manufacturer's recommended procedure and as outlined in Part 3 of this specification. Pressure testing shall use water as the test media.
6. Manufacturer: PLEXCO Performance Pipe Division – Chevron Chemical Company, or equal.

2.8 COPPER TUBING

- A. Federal Specifications WW-T-799C.
 1. Type: Type K, hard drawn, for all pipe cast in concrete, buried or where shown on the Drawings. Type L, hard drawn, for all other pipe applications.
 2. Fittings: Nibco or equal, wrought solder type, ANSI B16.22.
 3. Joints: Soldered, make with noncorrosive paste flux and solid string or wire solder. Core solder is not permitted.

2.9 STAINLESS STEEL (SS) PIPE

- A. Materials: Stainless steel pipe and fittings (300 psi at 200 deg F maximum). All stainless steel pipe and fittings shall be fabricated from Type 304L stainless steel sheet and plate.
- B. All stainless steel piping shall have as a minimum the nominal wall thickness dimensioned as shown on the Drawings. The required Schedule/Gauge/Plate and Wall Thickness are to be indicated in the manufacturer's shop drawings and verified by ASME B31.3 calculations. Piping wall thickness shall be designed for the hydrostatic test pressure as required. Calculations for wall thickness shall be based on the minimum wall thickness due to manufacturing tolerances, joint efficiencies, and a safety factors as permitted by ASME B31.3.
- C. Pipe
 1. Pipe shall conform to ASTM A-312 and be die-formed or rolled true to dimension and round within the applicable ANSI Standard. The two edges of sheet shall be brought to line so as not to leave a shoulder on the inside of the pipe.
 2. Pipes shall be straight within the applicable ANSI Standard for ASTM-A-312 welded pipe.
 3. Ends of pipe and fittings shall be true and perpendicular to the longitudinal axis with the edges deburred.
 4. Fittings shall conform to ASTM A-403-WP in accordance with B16.9.

5. Longitudinal seams on pipe and fittings shall be welded by the GTAW, PAW, FCAW, SAW, or the SMAW methods. Filler metal, if utilized, shall be of same composition or superior to the pipe and fittings material.
6. Weld deposit at the seams shall have a slight crown on both sides of the weld and no cracks or crevices shall be allowed. Excessive weld deposits, slag, weld spatter and projections into interior of pipe shall be removed by grinding. The interior welds shall be smooth, even and shall not have an internal bead higher than 1/16 inch.
7. All pieces shall be marked indicating wall thickness/schedule, grade of stainless steel, and ASTM Standard.
8. All pieces shall be marked indicating wall thickness/schedule, grade of stainless steel, and ASTM Standard. ASTM A312, Type 304/304L or 316/316L, Schedule 5, 10, or 40. Roll or Cut grooved as appropriate to the pipe material, wall thickness, pressure, size and method of joining. Use Victaulic RX roll sets specifically designed for grooving schedule 5 or 10 stainless steel pipe.

D. Fittings

1. Fittings shall be butt weld type per ASTM-A-403WP and manufactured in accordance with ANSI B16.9. All fittings shall be of the same pressure rating and grade material as the pipe.
2. Elbows shall be long radius Long radius; i.e., centerline to end of elbow equals 1.5 times the nominal pipe size, unless otherwise approved by the Engineer. All elbows up to 24-inch diameter shall be smooth flow. All short radius, special radius, and reducing elbows and long radius elbows greater than 24-inch diameter shall be of mitered construction with at least (5) miter sections for 90 degree bends, (3) mitered sections for 45 and 60 degree bends, and (2) mitered sections for 30 degree and smaller bends. Reducers shall be straight tapered, cone type.
3. Fittings three inches and smaller shall be threaded conforming to ASTM-A-182 forged, Class 3000# and manufactured to ANSI B16.11.
4. Fittings for buried or submerged pipe larger than three inches shall be butt-welded, conforming to ASTM-A-403WP, same pressure rating and material as the pipe and manufactured to ANSI B16.9.
5. Fittings for above ground or exposed pipe larger than three inches shall be butt-welded except when flanged or coupled, as shown on the drawings, conforming to ASTM A 403 WP, same pressure rating and grade material as the pipe and manufactured to ANSI B16.9. Tees shall have no welds in the throat area and the crotch shall be reinforced with long radius design to eliminate sharp corners. Extruded branch outlets may be used in place of reducing outlet tees when properly designed and manufactured per ASME B31.3 to meet the applicable operating, design, and test pressures as specified herein.
6. Grooved End Fittings: Fittings shall be manufactured of stainless steel conforming to ASTM A-403, WPW, WPW/S9, or CR/S9, or shall be fabricated from stainless steel pipe conforming to ASTM A312, with factory grooved ends. Fittings shall be type 304/304L or 316/316L stainless steel.

E. Drain and Instrumentation Branches

1. Outlets of size three inches and smaller in piping 4 inches and larger shall be of the Thredolet type, per AWWA Manual M11 (1964 edition), Figure 19.24. Outlets shall be 3,000 pound WOG stainless steel per ASTM A 182, or ASTM A 403. Threads shall comply with ANSI B2.01. Outlets shall be Bonny Forge Co. "Thredolet," Allied Piping Products Co. "Brachlet," or equal.
2. For outlets three inches and smaller in piping smaller than four inches, use a threaded tee in accordance with Section D above.

3. For outlets larger than three inches, use a tee conforming to ASTM-A-403WP, in accordance with Section D above and with a flanged outlet or as shown on the Drawings.
- F. Process Piping Branches
1. Reducing outlets of size 8 inches to 1-1/4 inches for skid process piping headers shall be fabricated of 304L stainless steel, ASTM SA-312, to match the material and construction of the header pipe. Fabricated outlets shall be extruded with a single butt weld in accordance to ASME B31.3 to connect the outlet branch to the header pipe.
- G. Joints
1. Joints for pipes three inches and smaller shall be threaded, grooved or socket welded, same material as the pipe, 3,000 pound WOG, conforming to ANSI B16.11.
 2. Joints for buried or submerged pipe larger than three inches shall be butt-welded.
 3. Joints for aboveground or exposed pipe larger than three inches shall be grooved or butt-welded except where flanges or grooved end joints are shown on the Drawings.
- H. Mechanical Couplings for Joining Stainless Steel Pipe:
1. Stainless Steel Mechanical Couplings: Manufactured in two or more segments of cast stainless steel, conforming to ASTM A-351, A-743, and A-744. Gaskets shall be pressure-responsive synthetic rubber, grade to suit the intended service, conforming to ASTM D-2000. (Gaskets used on potable water systems shall be UL classified in accordance with ANSI/NSF-61 for potable water service.) Mechanical coupling bolts shall be stainless steel, Type 316, meeting the physical properties of ASTM A-193, grade B8M, Class 2.
 - a. Rigid Type: Cast with key designed to clamp the bottom of the groove to provide an essentially rigid joint. Victaulic Series 489.
 - b. Flexible Type: Use in locations where vibration attenuation and stress relief are required. Victaulic Series 77S.
 2. Ductile Iron Mechanical Couplings: Manufactured in two segments of cast ductile iron, conforming to ASTM A-536. Gaskets shall be pressure-responsive synthetic rubber, grade to suit the intended service, conforming to ASTM D-2000. Mechanical coupling bolts shall be zinc plated (ASTM B-633) heat treated carbon steel track head conforming to ASTM A-449 and A-183, minimum tensile strength 110,000 psi (758450 kPa).
 - a. Sizes to 12", rigid type, designed to clamp the bottom of the groove to provide an essentially rigid joint. Victaulic Series 89.
 - b. 14" through 24": Victaulic AGS series with lead-in chamfer on housing key and wide width gasket. Rigid type, housing key shall fill the wedge shaped AGS groove and provide rigidity. Victaulic Style W89.
 - c. 2" through 4" sizes may be Installation-Ready, for direct stab installation without field disassembly, with grade EHP gasket rated to +250 deg F / 120 deg C. Victaulic Style 107H (rigid) or Style 177 (flexible).
 3. Flange Adapters: For use with grooved end pipe and fittings, for mating to ANSI Class 125 flanged components. Victaulic Style 441.
 4. Split-Sleeve (Depend-O-Lok) Couplings
 - a. Housing: Carbon steel to ASTM A36 or stainless steel to ASTM A240; double-arched rolled housing with closure plates.
 - b. Gasket: O-ring type of an elastomer suitable for the intended service and conforming to ASTM D2000.
 - c. Bolts and Nuts: ASTM A325 / A193 / A194 electroplated steel or ASTM F593 / F594 stainless steel, Type 316.

- d. Restraint Rings: ASTM A108 grade 1018, or ASTM A276 type 316L stainless steel; welded to pipe OD for restrained joints.
 - e. Basis of Design: Victaulic Depend-O-Lok; FxF (restrained); ExE (expansion); and FxE (combination).
- I. Flanges
- 1. Provide weld-neck flanges conforming to ANSI B16.5 for piping three inches and smaller to connect to flanged valves, fittings, or equipment. Provide slip-on flanges for piping larger than three inches. Provide blind flanges at dead end connections and where shown on the Drawings.
 - 2. Flanges shall be Class 150 per ANSI B16.5 unless a higher pressure rating is required. Flanges shall be Class 300 for the reverse osmosis feed water piping. Material for weld-neck, slip-on, and blind flanges shall conform to ASTM-A-182, Grade F304L. Flanges and blind flanges shall match the connecting flanges on the adjacent fitting, valve or piece of equipment.
 - 3. Where a raised face steel flange connects to a flat face flange, remove the raised face on the steel flange.
 - 4. Bolts and nuts for flanges shall be Type 316 stainless steel conforming to ASTM A 193, Grade B8M, for bolts and ASTM A 194, Grade 8M, for nuts.
 - 5. Provide washer for each nut. Washers shall be of the same material as the nuts.
 - 6. Provide full-face gaskets for flat faced flanges. Provide ring gaskets for raised face flanges. Gaskets shall be composed of asbestos with rubber binder, 1/8-inch thick, Johns-Manville No. 60, John Crane Co. "Granite", or equal for high temperature air service and shall be constructed of EPDM for ambient temperature water service.
- J. Pipe ends shall be prepared for either mechanical or flexible couplings where shown on the Drawings.
- K. Dead Ends of pipe runs shall have butt-welded ASME Code dished heads designed to meet the test pressures required.
- L. Gaskets shall be suitable for the service conditions. The pipe ends shall be roll grooved to the coupling manufacturer's specifications for piping size 6-inches and under. Where roll grooving is not sufficient for the specified pressure, the pipe shall have heavy wall machine grooved pipe nipples or machined ring collars fully welded to the pipe or fitting. Nipples shall be taper bored to the I.D. of the adjoining pipe to allow full weld penetration. Collars shall be welded on both sides to the piping. Nipples and collars shall be of the same alloy as the piping.
- M. Following final fabrication, all stainless steel pipe spools and fittings shall be cleaned and descaled in accordance with the requirements of ASTM A-380. Descaling shall include immersion in an appropriate pickling solution for the type and grade of material being treated. Caution shall be taken to avoid over-pickling. The type of acid used, acid concentration, solution temperature, and contact time shall be consistent with industry standards for such work. In addition to pickling, piping and fittings shall be scrubbed and washed until discoloration and possible iron, picked up from manufacturing process, is removed. Pickling and passivation of individual pipe lengths and fittings will not be considered equal to pickling and passivation of the finished product(s) following fabrication.
- N. After chemical descaling, surfaces shall be thoroughly rinsed to remove residual chemicals. Surfaces shall not be permitted to dry between successive steps of the acid descaling and rinsing procedure. Following the final rinse, thorough air drying shall be performed.

- O. Quality Control
 - 1. Contractor shall follow Manufacturer's and Supplier's recommended product quality control specifics as required for project.
 - 2. Piping subcontractor shall submit a list of welders who will work on this project along with a welder's current certification (less than one-year-old) and two sample weld coupons. Only approved welders will be allowed to work on this project.
 - 3. The weld should be made as rapidly as possible, with the least amount of generated heat.
 - 4. All shop welds shall be visually inspected by the fabricator's quality control division. Each weld shall be marked with an inspection stamp, certifying that the weld is acceptable.

- P. Installation
 - 1. Stainless steel piping shall be installed true to alignment and rigidly supported.
 - 2. After installation, completed pipelines shall be washed clean with steam or hot water to remove any foreign material picked up during transportation.
 - 3. Field Welded Piping: Field joint welding shall be in accordance with the ASME B31.3 standards. The strength of the weld shall develop the strength of the pipe. All field welds shall be descaled and passivated with pickling paste, scrubbed with stainless wire brushes and rinsed until clean.
 - 4. Installation Threaded Piping: Ream, clean and remove burrs from threaded straddling the pipe's horizontal and vertical centerline. Install pipe without springing, forcing, or stressing the pipe or any adjacent connecting valves or equipment.

2.10 HASTELLOY C PIPE AND TUBING

- A. Hastelloy C pipe and tubing shall conform to the requirements of ASTM B 626 Grade C276 (UNS N10276).

2.11 MISCELLANEOUS PIPING MATERIALS/PRODUCTS:

- A. Welding Materials: Except as otherwise indicated, provide welding materials as determined by Installer to comply with installation requirements.
 - 1. Comply with Section II, Part C, ASME Boiler and Pressure Vessel Code for welding materials.

- B. Soldering Materials: Except as otherwise indicated, provide soldering materials as determined by Installer to comply with installation requirements.
 - 1. Tin-Lead Solder: ASTM B 32, Grade 50A.
 - 2. Tin-Antimony Solder: ASTM B 32, Grade 95TA.
 - 3. Silver-Lead Solder: ASTM B 32, Grade 96TS.

- C. Brazing Materials: Except as otherwise indicated, provide brazing materials as determined by Installer to comply with installation requirements.
 - 1. Comply with SFA-5.8, Section II, ASME Boiler and Pressure Vessel Code for brazing filler metal materials.

- D. Gaskets for Flanged Joints: ANSI B16.21; full-faced for cast-iron flanges; raised-face for steel flanges, unless otherwise indicated.

- E. Piping Connectors for Dissimilar Non-Pressure Pipe: Elastomeric annular ring insert, or elastomeric flexible coupling secured at each end with stainless steel clamps, sized for exact fit to pipe ends and subject to approval by plumbing code.

1. Manufacturer: Subject to compliance with requirements, provide piping connectors of the following:
 - a. Fernco, Inc.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install pipes and pipe fittings in accordance with recognized industry practices which will achieve permanently-leakproof piping systems, capable of performing each indicated service without piping failure. Install each run with minimum joints and couplings, but with adequate and accessible unions for disassembly and maintenance/replacement of valves and equipment. Reduce sizes (where indicated) by use of reducing fittings. Align piping accurately at connections, within 1/16" misalignment tolerance.
 1. Comply with ANSI B31 Code for Pressure Piping.
- B. Locate piping runs, except as otherwise indicated, vertically and horizontally (pitched to drain) and avoid diagonal runs wherever possible. Orient horizontal runs parallel with walls and column lines. Locate runs as shown or described by diagrams, details and notations or, if not otherwise indicated, run piping in shortest route which does not obstruct usable space or block access for servicing building and its equipment. Hold piping close to walls, overhead construction, columns and other structural and permanent-enclosure elements of building; limit clearance to 1/2" where furring is shown for enclosure or concealment of piping, but allow for insulation thickness, if any. Where possible, locate insulated piping for 1" clearance outside insulation. Wherever possible in finished and occupied spaces, conceal piping from view, by locating in column enclosures, in hollow wall construction or above suspended ceilings; do not encase horizontal runs in solid partitions, except as indicated.
- C. Electrical Equipment Spaces: Do not run piping through transformer vaults and other electrical or electronic equipment spaces and enclosures unless unavoidable. Install drip pan under piping that must be run through electrical spaces.

3.2 PIPE EXPANSION CONTROL: INSTALLATION

- A. Install expansion loops or joints as required, to limit strain and movement of the piping.
 1. All loops shall be cold sprung when installed.
 2. Install conforming manufactured guides for each loop and joint to maintain the proper pipe alignment and minimize undue stresses on the piping and joints.
 3. All mechanical joints and guides shall be installed in accordance with the Manufacturer's recommendations.
 4. Install conforming manufactured pipe anchors at the midpoint between loops and joints. Installation and design shall be subject to the approval of the Engineer or Owner.
 5. Manufacturer shall be held responsible for the proper capacity of the joints, with a minimum 25% allowance beyond the anticipated expansion and contraction in the piping.
- B. Polyvinyl Chloride (PVC) Pipe: Provide expansion joints in straight piping runs over 50 feet and at least every 50 feet. Shall be Proco Series 261 or equal based on Chemical compatibility.

3.3 EXPOSED PIPING: INSTALLATION

- A. Do not obstruct passageways, headroom, door and window operation, and similar areas with the installation of the piping and supports.
- B. Painting of piping is specified elsewhere in the Contract Documents.
- C. Install straight runs true to line and elevation.
- D. Install vertical pipe plumb in all directions.
- E. Install piping parallel or perpendicular to building walls. Piping at angles and 45 deg runs across corners shall not be accepted unless specifically shown.

3.4 PIPING SYSTEM JOINTS

- A. General: Provide joints of type indicated in each piping system.
 - 1. Make joints in accordance with the pipe Manufacturer's recommendations and the requirements below.
 - 2. Cut piping accurate and square. Assemble without forcing or springing.
 - 3. Ream all pipes and tubing to full inside diameter after cutting. Remove sharp edges on end cuts.
 - 4. Remove all cuttings and foreign matter from the inside of pipes and tubing before installation.
 - 5. Thoroughly clean all pipe, fittings, valves, specials, and accessories before installing.
 - 6. Thoroughly wire-brush, wipe clean and dry all spigot mating surfaces immediately before pipe is installed.
- B. Threaded Joints
 - 1. Thread pipe in accordance with ANSI B2.1.
 - 2. Use standard right hand tapered full depth threads on steel piping.
 - 3. Apply before installation an approved joint compound to the male threads only.
 - 4. Leave three pipe threads maximum exposed at each connection.
- C. Braze copper tube-and-fitting joints where indicated, in accordance with ANSI B31.
- D. Solder copper tube-and-fitting joints where indicated, in accordance with recognized industry practice. Cut tube ends squarely, ream to full inside diameter, and clean outside of tube ends and inside of fittings. Apply solder flux to joint areas of both tubes and fittings. Insert tube full depth into fitting, and solder in manner which will draw solder full depth and circumference of joint. Wipe excess solder from joint before it hardens.
- E. Flanged Joints: Use hexagon head nuts and bolts. Match flanges within piping system, and at connections with valves and equipment. Assemble flanged joints with gaskets and gasket compounds in compliance with the applicable material specifications. Tighten flange bolts evenly to provide uniform compression of gaskets.
- F. Plastic Pipe/Tube Joints: Comply with manufacturer's instructions and recommendations, and with applicable industry standards:
 - 1. Heat Joining of Thermoplastic Pipe: ASTM D 2657.
 - 2. Making Solvent-Cemented Joints: ASTM D 2235, and ASTM F 402.

- G. Resulting joint is minimum of 3 times as long as thickness of thinner joint member, and brazed using B-CuP series filler metal.
- H. Mechanically Formed Couplings: In lieu of providing couplings in copper tubing, Installer may, as option, provide mechanically formed couplings, provided they are in accordance with the following:
 - 1. Form couplings by first annealing area at end of tube where expansion will occur. Insert tube expander to die size required and expand tube end to accept tubing of same size.
 - 2. Resulting joint is minimum of 3 times as long as thickness of tube, and brazed using B-CuP series filler metal.
- I. Weld pipe joints in accordance with ASME Code for Pressure Piping, B31.
 - 1. Weld pipe joints in accordance with recognized industry practice and as follows:
 - 2. Weld pipe joints only when ambient temperature is above 0 deg F (-18 deg C) where possible.
 - 3. Bevel pipe ends at a 37.5 deg angle where possible, smooth rough cuts, and clean to remove slag, metal particles and dirt.
 - 4. Use pipe clamps or tack-weld joints with 1" long welds; 4 welds for pipe sizes to 10", 8 welds for pipe sizes 12" to 20".
 - 5. Build up welds with stringer-bead pass, followed by hot pass, followed by cover or filler pass. Eliminate valleys at center and edges of each weld. Weld by procedures which will ensure elimination of unsound or unfused metal, cracks, oxidation, blow-holes and non-metallic inclusions.
 - 6. Do not weld-out piping system imperfections by tack- welding procedures; refabricate to comply with requirements.
 - 7. At Installer's option, install forged branch-connection fittings wherever branch pipe is indicated; or install regular "T" fitting.
 - 8. At Installer's option, install forged branch-connection fittings wherever branch pipe of size smaller than main pipe is indicated; or install regular "T" fitting.
- J. Weld pipe joints of steel water pipe in accordance with AWWA C206.
- K. Hubless Cast-Iron Joints: Comply with coupling manufacturer's installation instructions.
- L. Grooved Pipe Joints: Comply with fitting manufacturer's instructions for making grooves in pipe ends. Remove burrs and ream pipe ends. Assemble joints in accordance with manufacturer's instructions.

3.5 FITTINGS

- A. Unions
 - 1. Install dielectric unions where dissimilar metals are connected except at bronze or brass valves installed in ferrous piping.
 - 2. Provide a union downstream of each screwed end valve.
 - 3. Provide screwed or flanged unions at each piece of equipment, where shown, and where necessary to install or dismantle piping.
- B. Eccentric Reducers: Use eccentric reducers where shown and where air or water pockets would occur in mains because of reduction in pipe size.

- C. Transitions between Types of Pipe: Provide all necessary adapters, specials and connector pieces when connecting different types and sizes of pipe or connecting pipe furnished by different Manufacturers.
- D. Mechanically Formed Tee Connections: In lieu of providing tee fittings in copper tubing, Installer may, as option, provide mechanically formed tee connections, providing they are in accordance with the following:
 - 1. Size and wall thickness of both run tube and branch tube are listed by Manufacturer of forming equipment as "Acceptable Application".
 - 2. Height of drawn collar is not less than 3 times wall thickness of run tubing.
 - 3. End of branch tube is notched to conform to inner curve of run tube, and dimpled to set exact penetration depth into collar.
- E. Restraints, Supports and Thrust Blocks
 - 1. Install restrained joints as shown, specified, recommended by Manufacturer, or otherwise required.
 - 2. Provide concrete and metal cradles, collars, kickers, and blocks as indicated.
- F. Expansion coupling
 - 1. Install expansion couplings in tension to facilitate their removal.
 - 2. Set stretcher bolts for maximum allowable elongation of expansion coupling as recommended by the Manufacturer.
- G. Adjustment: Adjust all parts and components as required to provide correct operation.
- H. Identification of Piping: Paint, identify contents of piping and flow direction, and coordinate color coding of both insulated and non-insulated piping with Division 09 Section.

3.6 PVC AND CPVC PIPE INSTALLATION

- A. General
 - 1. Do not install pipe when the temperature is below 40 deg F or above 90 deg F. Store loose pipes on racks with a minimum support spacing of 3 feet. Provide shade from direct sunlight for pipe stored outdoors or installed outdoors until the pipe is filled with water.
 - 2. Store fittings indoors in their original cartons.
 - 3. Store solvent cement indoors or, if outdoors, shade from direct sunlight. Do not use solvent cements which have exceeded the shelf life marked on the storage container.
 - 4. Before installation, check pipe and fittings for cuts, scratches, gouges, buckling, kinking, or splitting on pipe ends. Remove any pipe section containing defects by cutting out the damaged section as a complete cylinder.
- B. Installation
 - 1. Do not drag PVC pipe over the ground, drop it onto the ground, or drop objects on it.
 - 2. Cut pipe ends square and remove all burrs, chips, and filings before joining pipe or fittings.
 - 3. Bevel solvent welded pipe ends as recommended by the pipe manufacturer.
- C. Solvent Welded Joints
 - 1. Prior to solvent welding, remove fittings and couplings from their cartons and expose them to the air for at least one hour to the same temperature conditions as the pipe.

2. Wipe away loose dirt and moisture from the ID and OD of the pipe end and the ID of the fittings before applying solvent cement. Do not apply solvent cement to wet surfaces.
3. Make up solvent welded joints per ASTM D 2855.
4. Allow at least eight hours of drying time before moving solvent welded joints or subjecting the joints to any internal or external loads or pressures.

D. Flanged Joints

1. Lubricate stainless steel bolt threads with specified materials before installation.
2. Tighten bolts on flanges by tightening the nuts diametrically opposite each other using a torque wrench. Complete tightening shall be accomplished in stages and the final torque values shall be as shown in the following table:

Pipe Size (inches)	Final Torque (Ft-Lb)
1/2 - 1-1/2	10-15
2-4	20-30
6-8	33-50
10	53-75
12	80-110
14-24	100

E. Threaded Joints

1. Cut threaded ends on pipe to the dimensions of ANSI B2.1. Ends shall be square cut. Follow the pipe manufacturer's recommendations regarding pipe holddown methods, saw cutting blade size, and saw cutting speed.
2. Pipe or tubing cutters shall be specifically designed for use on plastic pipe.
3. If the holddown vise is used when pipe is cut, insert a rubber sheet between the vise jaws and the pipe to protect from scratching the pipe.
4. Thread cutting dies shall be clean and sharp and shall not be used to cut materials other than plastic.
5. Not more than three threads shall remain exposed after installation.
6. All joints shall be wrapped with Teflon tape.

3.7 SLEEVES: INSTALLATION

- A. Provide and accurately locate all sleeves required under this Section. Set sleeves true to line, grade and position, plumb or level, and maintain as such during the work under other Divisions.
- B. Sufficient advance notice shall be supplied to SLEEVES: INSTALLATION the proper trade to enable the installation to progress.
- C. Whenever improper location or insufficient notice is provided for the installation of the sleeves, such work shall be done as Work of this Section, with no change in the Contract Sum or the Date of Substantial Completion.

- D. Sleeves shall not penetrate any structural member except as shown on the Drawings.
- E. Provide 8-inch clear space between sleeves unless otherwise indicated on the Drawings.
- F. Sleeves shall be of the full thickness, with the exposed ends flush and smooth, with the structure in which they are installed.
- G. Wherever water might get into the sleeve, the sleeves shall extend 1 inch above the finished surface and be made watertight. The exposed end shall be smooth and neatly finished.
- H. On all piping passing through a sleeve, the piping insulation shall be continuous through the sleeve. The sleeve shall be sized to allow a 1-inch annular space between the sleeve and the bare pipe or insulation.
- I. Sealing of Sleeves and Penetrations
 - 1. Where sleeves are embedded through cast-in-place concrete walls or slabs on or below grade, the joints between the concrete and the sleeve shall be sealed with a polyurethane sealer.
 - 2. Where sleeves pass through boxed out or cored openings in concrete walls or floor slabs on or below grade, a bonding agent shall be applied to the concrete surface and a nonshrink grout shall be installed between the concrete and the sleeves. After the grout has cured, the joints between the grout and the sleeves on both sides of the wall or floor shall be sealed with a polyurethane sealer.
 - 3. Where sleeves pass through exterior building walls above grade, the joints between the wall and sleeve on both sides of the wall shall be sealed with silicone sealer or the opening shall be sealed with silicone foam.
- J. The 1-inch annular space around pipes passing through sleeves shall be filled with silicone foam having a minimum service temperature rating at least 15 deg F higher (8.3 deg C higher) than the temperature of the pipe service passing through it.

3.8 TESTING

- A. General
 - 1. All pipe lines shall be tested to prove tightness of the final assembly. The Engineer shall be given 24 hours' notice before each test.
 - 2. All tests required by governing authorities shall be satisfactorily made.
 - 3. Provide all necessary testing apparatus, including gages, pumps, hoses, and fittings.
 - 4. Repair and retest pipelines which fail to hold specified test pressure or which exceed the allowable leakage rate.
 - 5. Test pressures specified apply at the lowest elevation of the pipeline section being tested unless otherwise noted.
 - 6. The Contractor is responsible for all testing and shall pay all costs incurred during the specified testing.
- B. Hydrostatic Pressure Testing
 - 1. General
 - a. Conduct hydrostatic pressure testing on all process piping in accordance with AWWA C600.

- b. Slowly fill section to be tested with water and expel all air. Install corporation cocks as necessary to remove air.
 - c. Apply test pressure for two (2) hours.
 - d. Observe each test section for leakage at end of test period. Test fails if leakage is observed or if pressure drop exceeds 5% of test pressure.
2. Exposed Piping
- a. Allow any concrete which may be affected by the testing to reach design strength before testing.
 - b. Ensure that all supports and restraint protection are securely in place.
3. Buried Piping
- a. Place and compact backfill to at least the pipe centerline before testing, unless otherwise required or acceptable to the Engineer. Backfill and compact around all blocking before testing and as required to assure restraint by harnessed joints.
 - b. Allow concrete for blocking to reach design strength before testing.
4. Test Pressure
- a. Test long runs of Schedule 40 pipe at 150 psi, except where fittings are a lower Class or pressure rating.
 - b. Test each piping system at 150% of operating pressure indicated, but not less than 25 psi test pressure.
 - c. Piping connected to pump suction and discharge: 150% of specified maximum operating head of pump.
 - d. Gravity flow ductile iron pipe: 150% of maximum static water head of pipe section being tested.
 - e. Liquid chemical feed piping: 100 psi
- C. C. Allowable Leakage: Leakage shall not exceed:

$$L = \frac{SD(P)^{1.5}}{133,200}$$

Where

L = Allowable leakage, gallons per hour.

S = Length of pipe tested, feet.

D = Nominal diameter or pipe, inches.

P = Average test pressure, psig.

3.9 CLEANING, FLUSHING, INSPECTING

A. General

1. All piping systems shall be cleaned and flushed out prior to operation. If it is necessary to place the system in operation by sections, then the cleaning shall be done by sections. Notify Owner prior to start of Work.
2. Inspect inside of piping 24-inch diameter and larger and remove all debris, dirt and foreign matter.
3. All piping, including equipment installed in connection with the piping, conveying liquids shall be filled and flushed several times to eliminate all debris and contaminants.
4. Where pumps are installed, install temporary strainers ahead of pumps and circulate the medium through several cycles. The system shall be flushed out and the temporary strainers removed. Strainers shall have a free area of at least 3 times the cross sectional area of the attached pipe.

5. Prior to turning over the Work, this Contractor shall remove and clean all strainers, traps, and dirt pockets.
 6. All process piping shall be pigged and flushed.
- B. Disinfection
1. Standard: AWWA C651 unless otherwise acceptable to the Engineer or Owner.
 2. Disinfect all potable water piping.
 3. Flush piping with water at 2-1/2 feet per second minimum velocity prior to disinfection.
 4. Water for flushing, testing and chlorination will be furnished by Owner at no cost to Contractor.
 5. Chlorine shall be supplied by Contractor.
 6. All other labor, material and equipment including chlorination taps and blow-off taps shall be furnished and paid for by the Contractor.
 7. Chlorine Concentration
 - a. Maintain chlorine concentration between 50 and 100 parts per million for water entering the pipe.
 - b. 25 parts per million minimum residual concentration shall remain after 24 hr. retention period.
 - c. Repeat the operation as necessary to provide complete disinfection.
 8. Provide two safe total coliform samples taken 24 hours apart prior to placing pipe in service. Provide results to Ohio EPA and the Engineer.
- C. Test pressure piping in accordance with ASME B31.
- D. General: Provide temporary equipment for testing, including pump and gages. Test piping system before insulation is installed wherever feasible, and remove control devices before testing. Test each natural section of each piping system independently but do not use piping system valves to isolate sections where test pressure exceeds valve pressure rating. Fill each section with water and pressurize for indicated pressure and time.
1. Required test periods is 2 hours.
 2. Test long runs of Schedule 40 pipe at 150 psi, except where fittings are a lower Class or pressure rating.
 3. Test each piping system at 150% of operating pressure indicated, but not less than 25 psi test pressure.
 4. Observe each test section for leakage at end of test period. Test fails if leakage is observed or if pressure drop exceeds 5% of test pressure.
- E. Repair piping systems sections which fail required piping test, by disassembly and re-installation, using new materials to extent required to overcome leakage. Do not use chemicals, stop-leak compounds, mastics, or other temporary repair methods.
- F. Drain test water from piping systems after testing and repair work has been completed.

END OF SECTION 402336

SECTION 402337 – EXPANSION JOINTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes pipe expansion fittings for process piping systems, including the following:
 - 1. Rubber expansion joints

1.3 PERFORMANCE REQUIREMENTS

- A. Compatibility: Products suitable for piping system fluids, materials, working pressures, and temperatures.
- B. Capability: Absorb 200 percent of maximum piping expansion between anchors.

1.4 SUBMITTALS

- A. Product Data: For each type of expansion fitting indicated.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Rubber Expansion Joints:
 - a. Flexicraft Industries
 - b. Or approved equal.

2.2 RUBBER ULTRASPOOL EXPANSION JOINTS

- A. Expansion joints shall be a rubber spool type of a single and double, open wide arch design. Joint construction shall consist of an elastomer tube and cover, reinforced with a suitable woven fabric and steel rings support. Tube cover elastomers shall be selected to accommodate the process and environment conditions. Joints shall be designed to meet the design pressure and temperature for the system.
- B. Expansion joints ends shall be steel flanges drilled to 300 lbs class standards, and be full rubber faced and integral to the body. Split flange backing rings of galvanized carbon steel shall be provided.

- C. Expansion joints shall be capable of accommodating piping system and equipment movements and vibration as needed.
- D. Control units with tie rods of galvanized carbon steel shall be included to prevent overextension of the expansion joints from pressure thrust loads. The number and size of the control unit cables shall be sufficient for the maximum system test pressure.
- E. Coordinate expansion joint pressure and temperature rating with piping system. The upper temperature limit shall be 230°F.
- F. Backing rings and control units shall be provided in galvanized steel.

PART 3 - EXECUTION

3.1 EXPANSION FITTING INSTALLATION

- A. Install expansion fittings according to manufacturer's written instructions.
- B. Install expansion fittings in sizes matching pipe size in which they are installed.
- C. Align expansion fittings to avoid end-loading and torsional stress.

END OF SECTION 402337

SECTION 406196 - FUNCTIONAL NARRATIVES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and all Specification Sections, apply to work of this section.
- B. Referenced Sections:
 - 1. Section 407000 - Instrumentation and Control System General Requirements
 - 2. Section 409600 - PLC and SCADA System

1.2 DESCRIPTION OF WORK

- A. This Section includes the basic equipment programming to be performed by the Project Systems Integrator.
- B. Description of the Process Instrumentation and Control.

1.3 GENERAL REQUIREMENTS

- A. The specifications and drawings outline certain characteristics of the monitoring and control system but do not set forth all the details of system design and the various functions and equipment required. All equipment shall be complete with all necessary software, accessories, and appurtenances required for a properly operating system including all items recommended by respective manufactures and not herein specified.
- B. The Contractor shall assume complete system responsibility through a system integrator and provide all necessary coordination with any and all subcontractors.
- C. The Contractor shall coordinate the work of the system integrator for the installation, interconnection, testing, and calibration of the instruments, and the scheduling of the system integrator's personnel. The system integrator shall be responsible for assuring that this equipment properly meets the functional intent of the specifications. Substitutions on functions specified are subject to review and approval.
- D. The system integrator shall be required to demonstrate a minimum of five years recent, past experience in the design, integration, and commissioning of SCADA, instrumentation and control system, at least five projects of comparable size, type, and complexity to the proposed project.
- E. The system integrator shall have in his employ the capable personnel for detailed engineering, coordination, drafting, procurement and expediting, scheduling construction, testing, inspection, installation, start-up service for calibration and commissioning, and warranty compliance for the period specified.

1.4 QUALITY ASSURANCE

- A. Codes and Standards. Perform all work in compliance with applicable requirements of governing agencies having jurisdiction and in accordance with the plans and as specified herein.
 - 1. National Electrical Manufacturers Association (NEMA) Compliance.
 - 2. National Electric Code (NEC) Compliance.
 - 3. Instrument Society of America (ISA).
 - 4. Institute of General Construction and Electronic Engineers (IEEE).
 - 5. Underwriters' Laboratories, Inc. (UL) Compliance and Labeling. Comply with provisions of UL safety standards pertaining to process controller equipment. Provide products and components which have been UL listed and labeled.

1.5 SUBMITTALS

- A. The Contractor shall submit manufacturer's technical data and application instruction in accordance with the General and Supplementary Conditions and Division 1 Specifications and any additional information listed herein.
- B. Product Data: Include list which indicates use, operating range, total range, and location for manufactured components.

1.6 TESTING AND TRAINING REQUIREMENTS

A. Job Site Demonstration

- 1. Following final installation and calibration of the system, the Integrator shall perform a demonstration of system performance. Satisfactory performance shall require the system to perform control functions, monitoring and display functions, alarming, and printout functions for a period of not less than one (1) month of continuous operation. During this demonstration, any system failure or software-related problem shall be corrected, and the demonstration resumed. Acceptance of the control system by the Owner shall require that the system operates continuously for a period of one (1) month without non-field or field repairable hardware or software interruption. Substantial completion shall not be awarded until after the Integrator has successfully completed the above required test.

B. System Calibration and Start-up

- 1. The Integrator shall provide the initial calibration and startup of the control system by providing personnel to perform the following:
 - a. Supervise the installation and verify the final connections of all new signal wiring to and from the control system.
 - b. Perform all hardware calibration and diagnostic tests and make all necessary equipment connections.
 - c. Perform all configuration system tests, including diagnostics.
 - d. Perform the acceptance test as described in the "Job Site Demonstration" section of this specification.
 - e. Test the operation of the Communications Control System and Input/Output

Subsystem

1.7 SCADA AND PLC PROGRAMMING – GENERAL PROVISIONS

- A. The SCADA computer human/machine interface (HMI) shall be configured to allow the operators to perform data acquisition functions such as report generation, alarm management, trending, graphic presentation of process in real-time basis and control functions such as equipment on/off, set point changes, etc. for the process equipment. The computer shall also allow the override functions of control blocks upon the operator's command. Failure of the SCADA computers shall not interrupt the operation of the PLC system in performing control and monitoring functions.
- B. The SCADA system shall allow the plant personnel to monitor all associated processes and to change set points as required. It shall also provide status conditions, alarm conditions, display of trend and selected loop display. The system shall perform totalizing the recording functions of selected process variables (match existing).
- C. The system shall have the capability of storing all new process variables such as pressure, flow and level and shall provide either daily, weekly, or monthly printouts as selected by the operator. Status conditions, display of trends and selected loop display shall be provided.
- D. It shall be possible to manually toggle the "Out of Service" status within the SCADA system for all of the process equipment, instrumentation and areas.
- E. For those processes that include automated operation, as described below, manual remote operation shall always also be allowed. Toggling between manual and automatic operation shall be possible on the related control screen.

1.8 PROJECT RECORD DOCUMENTS

- A. Submit documents under provisions of Division 1 specifications.

PART 2 - PRODUCTS

2.1 PROCESS COMPONENTS

- A. General: New and existing instrumentation or analytical equipment values shall be displayed on the HMI and SCADA system as live data. The data also will be recorded and viewable on trends.
- B. This specification provides the description of controls for various process components.
 - 2.3 – Influent Lift Station and Flow Meter
 - 2.4 – Mechanical Screens and Grit System (Headworks)
 - 2.5 – Oxidation Ditch Splitter Box and Oxidation Ditch
 - 2.6 – Return Sludge Pumps and Flow Meter
 - 2.7 – WAS Meter and WAS Motor Operated Valve

- 2.8 – Final Clarifier (aka Secondary Settling Tanks)
- 2.9 – Tertiary Filter and Tertiary Pump Station
- 2.10 – UV Disinfection
- 2.11 – Sludge Transfer Lift Station (Aerobic Digesters 1-3)
- 2.12 – Sludge Feed Pumps to Dewatering Screw Press
- 2.13 – Dewatering Equipment
- 2.14 - Blowers

- C. The following set of control descriptions shall be incorporated in the Plant SCADA System designed and provided by the Plant System Integrator. These descriptions have been prepared based on specified equipment. The Plant System Integrator shall modify this document as required to accommodate actual approved equipment shop drawings.

2.2 DESCRIPTION

A. General Requirements:

1. Automatic / Remote / Local Control Switches, Indicating Lights and Trending
 - a. All devices controlled by SCADA shall have locally mounted indicating lights that identify the status of the device such as open-closed or on-off.
2. The requirements listed here shall be adhered to for all motor operated devices controlled by the SCADA System unless specifically stated otherwise elsewhere in this specification. Motor operated devices shall be equipped with locally mounted switches that provide “HAND-OFF- AUTO” (HOA) capability.
 - b. The “AUTO” position shall allow remote operation through the SCADA System. The “HAND” position shall allow local operation of the device. The “OFF” position shall disable all operation of the device. In addition, “START-STOP” controls shall be mounted locally on all motor operated devices. Additional local controls such as “FORWARD-REVERSE”, if required, will be identified with the control requirements of the specific device.
3. All devices controlled by SCADA shall have their run status monitored and total run time recorded through totalizers located in the respective PLCs. SCADA will be able to trend any tag in any PLC.

2.3 INFLUENT PUMP STATION AND PLANT INFLUENT FLOW METER

A. Description

1. Pumping System is furnished by the vendor with a PLC based control panel, programmed for automatic and local manual operation. SI to interface the control panel to plant SCADA PLC via Ethernet for monitoring of pump (x4) statuses (allow the inclusion for the fifth pump in the future), wet well level; discharge pressure gage, flow rate signal and remote manual control.

2. Influent Raw Wastewater Pump Station is equipped with a total of four (4) submersible pumps, radar level transmitter and floats for back-up control and high-level alarm, pressure gage.
3. The wastewater flow is fed by gravity into the Influent Lift Station. The wastewater flow rates range between 0 - 6 MGD, with the Average Day Design Flow (ADDF) = of 4 MGD and Peak Flow of 6 MGD. The flow is pumped through a 24-inch force main, which contains the existing plant influent magnetic flowmeter, FIT 110, located in the Headworks Screen and Grit Tank Building. The flowmeter signal shall be connected to the SCADA PLC via Ethernet in order to record influent wastewater flow, flow totalizing, and history.

B. Control Mode

1. HAND: The operator can manually start and stop the pumps as desired at the pumps control panel or remotely at SCADA OIT. While in Hand Mode, the pumps will be controlled directly by the VFDs.
2. AUTO: With the H/O/A selector in "Auto" the new Influent Pumps Control Panel will operate the four new pumps in lead-lag1-lag2-lag3 fashion. The fourth pump shall be used in a standby mode. The System Integrator (SI) shall program the new PLC to allow the inclusion of the fifth pump in the future. Automatic alternation of the pumps shall be utilized to equalize run times. Duty and Standby pumps shall alternate.
3. Alarm Summary
 - a. Pump Fault
 - b. High water alarm
 - c. HH Water Alarm – EQ flow On
4. Monitoring Parameters
 - a. Motor Run Status
 - b. VFDs (if used) - control, overload, and status feedback.
 - c. Levels (if used) - digital and analog devices.
 - d. Pressures (if used) – digital and analog devices.
 - e. Flow (if used) – digital and analog devices.
 - f. All Alarms, Faults
5. Summary of Settings
 - a. Lead Pump on elevation (to be field determined)
 - b. Lag Pump 2 on elevation 917.50 (to be field verified)
 - c. Lag Pump 3 on elevation 919.00 (to be field verified)
 - d. High Water Alarm elevation 920.50 (to be field verified)
 - e. Lag Pump 4 on elevation 921.00 (to be field verified)
 - f. All off elevations 913.00 (to be field verified)
6. Control Point
 - a. Pumps 1- 4 Run Commands
 - b. Pumps 1- 4 Speed References

2.4 MECHANICAL SCREENS AND GRIT REMOVAL SYSTEM

- A. Controls package for the Mechanical Bar Screens, Washer Compactor and Shaftless Screw

Conveyor system provided by the screen and washer compactor manufacturer, refer to specification Refer to Section 462116.

- B. Control package for the Grit Removal System includes Control Panel to control two (2) grit traps, two (2) grit pumps and one (1) grit classifier provided by the equipment manufacturer. Grit system is equipped with a unified control panel with a PLC capable of being connected to the plant SCADA System. Refer to Section 462300 for full list of signals to relay to SCADA System.
- C. SCADA PLC to mirror the monitoring screens provided by the Screen and Grit removal system suppliers on the respective control panels.

2.5 OXIDATION DITCH SPLITTER BOX AND OXIDATION DITCH

- A. The wastewater flow after initial treatment on the mechanical screen and grit removal system is fed by gravity into the Oxidation Ditch Splitter Box, where during normal operating condition mixes with the Return Activated Sludge (RAS) and overflows the controlled weir gate to the one of the Oxidation Ditch Aeration Channel. Oxidation Ditch Equipment will be controlled by the manufacturer’s control panel containing an Allen-Bradly CompactLogix PLC, provided pre-programmed by the Lakeside Equipment Corporation supplier. Refer to Section 465361.
 - 1. Monitoring Summary
 - a. Plant SCADA to mirror the Oxidation Ditch Local Control Panel functions provided by the Lakeside Equipment Corporation supplier.
 - 2. Alarm Summary
 - a. Motor Run Status
 - b. VFDs (if used) - control, overload, and status feedback.
 - c. All Alarms, Faults (Rotor Faults; Gate Faults)
 - d. Dissolved Oxygen – digital and analog devices
 - e. Levels (if used) - digital and analog devices.
 - f. Pressures (if used) – digital and analog devices.
 - g. Flow (if used) – digital and analog devices.
- B. Provided Instruments:

Motor operated modulating weir gates	SG-201 & SG-202	<ul style="list-style-type: none"> ▪ 4-20 mA signal: Slide Gate % Open ▪ Interlock: when SG-201 is "Open", the SG-202 is "Closed". ▪ From SG-201 flow passes to Oxidation Ditch 1 (OXI-1). ▪ From Slide Gate-202 flow passes to Oxidation Ditch 2 (OXI-2).
Radar Level Transmitter	LIT-201	<ul style="list-style-type: none"> ▪ 4-20 mA signal: show status of Splitter Box Level. ▪ Radar Level Sensor controls: Slide Gates, SG-201&202. ▪ OXI-PV-06: Motor operated RAS Plug Valve "Open/Close" position.

RAS to Splitter Box – Normally Open	OXI-PV-06	<ul style="list-style-type: none"> ▪ 4-20 mA signal: % Open Status. ▪ Interlock with OXI-PV-05. Output based on Splitter Box level paced. ▪ Level set point is flow-paced from the Influent Flowmeter (FIT-110).
RAS flow by-pass to the Oxidation Ditch 1 or 2	OXI-PV-05	<ul style="list-style-type: none"> ▪ 4-20 mA signal: % Open Status. ▪ Interlock between OXI-PV-06, OXI-PV-05, and OXI-PV-03/04: ▪ When OXI-PV-06 is “Open”, OXI-PV-05 shall be “Closed” and OXI-PV-03 & OXI-PV-04 remain “Closed”. ▪ When OXI-PV-06 is “Closed”, OXI-PV-05 is “Open” and either OXI-PV-03 or 04 is in “Open” position.
RAS flow to Oxidation Ditch No. 1 (East) RAS flow to Oxidation Ditch No. 2 (West)	OXI-PV-03 OXI-PV-04	<ul style="list-style-type: none"> ▪ 4-20 mA signal: % Open Status. ▪ Interlock SG-201/202 with OXI-PV-03/04. ▪ Interlock with WG-201 & -202. ▪ When SG-201 is “Open”, OXI-PV-03 is “Closed” and OXI-PV-04 is “Open”. ▪ When SG-202 is “Open”, OXI-PV-03 is “Open” and OXI-PV-04 is “Closed”.
Influent flow motor operated valves	OXI-PV-01 & OXI-PV-02	<ul style="list-style-type: none"> ▪ 4-20 mA signal: % Open Status. ▪ Interlock with SG-201/202.
Oxidation Ditch Effluent Slide Gates-motor operated	OXI-SG-211 OXI-SG-202	<ul style="list-style-type: none"> ▪ 4-20 mA signal: % Open Status. ▪ Interlock with SG-201/202: ▪ When SG-201 “Open”, OXI-SG-211 is “Closed” and OXI-SG-212 is “Open”. ▪ When SG-202 is “Open”, OXI-SG-211 is “Open” and OXI-SG-212 is “Closed”.
Dissolve Oxygen Meter	OXI1-DO-201 OXI2-DO-202	4-20 mA signal

The Oxidation Ditch aeration channels are designed to operate in Series. The wastewater from the splitter box can be selected to flow to one of the Oxidation Ditch channels, OXI-1 (East) or OXI-2 (West). Two Auto modes of operation will be provided a “Normal Flow Mode” and a “Peak Flow Mode”.

- C. **Oxidation Ditch Splitter Box:** Using the observed total flow from the existing plant influent transit time meter **FIT-110** the water level in the splitter chamber will be monitored using LIT-201 wherein the changing level will indicate the need for the Oxidation inlet weir gate to modulate in accordance with the following table to maintain an operated-entered set point. A PLC shall be provided to modulate the gate operation based on the plant influent flow. The System Integrator (SI) shall program the new SCADA PLC to allow the inclusion of the second train of Oxidation Ditch No. 3 & 4 (OXI-3 and OXI-4) in the future.

1. Summary of Settings
 - a. Activate Storm Mode flow rate – 5.0 MGD

b. Deactivate Storm Mode flow rate – 4.0 MGD

Once flows subside below the 5.0 MGD, de-activation threshold, the Storm Mode command shall be de-activated.

The head over the 3-ft weir to Oxidation Ditch No. 1/2 is shown in the table below.

Influent, MGD	Weir Head, ft	Influent, MGD	Weir Head, ft	Influent, MGD	Weir Head, ft
0.1	0.0439	2.1	0.4307	4.1	0.7113
0.2	0.0738	2.2	0.4460	4.2	0.7243
0.3	0.1001	2.3	0.4611	4.3	0.7372
0.4	0.1242	2.4	0.4760	4.4	0.7500
0.5	0.1468	2.5	0.4908	4.5	0.7627
0.6	0.1683	2.6	0.5055	4.6	0.7754
0.7	0.1889	2.7	0.5200	4.7	0.7880
0.8	0.2088	2.8	0.5344	4.8	0.8006
0.9	0.2281	2.9	0.5486	4.9	0.8131
1.0	0.2469	3.0	0.5627	5.0	0.8255
1.1	0.2652	3.1	0.5768	5.1	0.8378
1.2	0.2830	3.2	0.5907	5.2	0.8501
1.3	0.3006	3.3	0.6044	5.3	0.8623
1.4	0.3177	3.4	0.6181	5.4	0.8745
1.5	0.3346	3.5	0.6317	5.5	0.8866
1.6	0.3512	3.6	0.6452	5.6	0.8987
1.7	0.3675	3.7	0.6586	5.7	0.9107
1.8	0.3836	3.8	0.6719	5.8	0.9227
1.9	0.3995	3.9	0.6851	5.9	0.9346
2.0	0.4152	4.0	0.6983	6.0	0.9464

2. Control Mode

a. HAND: The operator can manually operate the modulating gates as desired using the control local to each actuator. at local control panel or remotely at SCADA PLC. When the H/O/A switch is placed in “Hand” position, the gate can be moved all the way fully opened or fully closed. While in “Hand” Mode, the PLC will not have control.

b. AUTO: With the H/O/A selector switch in the “Auto” position, the Oxidation Ditch Control Panel PLC will operate the gates based on Normal or Peak Flow /Storm Mode set points.

3. Gates Alarm Summary

- a. Gate Motor Fault
- b. Gate Fail to Open or Close
- c. Motor Operated Gate in Auto
- d. Gate % Open

4. Control Panel Display and Remote Monitoring Display

- a. Normal or Storm Operation Mode

- b. Oxidation Ditch Slide Gate, SG-201 & SG-202, positions in Splitter Box.
 - c. Water Level in the Splitter Box
 - d. Oxidation Ditch Influent Valves positions.
 - e. Oxidation Ditch RAS Valve positions.
 - f. Oxidation Ditch Effluent Slide Gate, SG-211 & 212, positions.
 - g. DO Probes Level Readings
5. Control Points (Outputs)
- a. Gate Open Command (DO)
 - b. Gate Close Command (DO)
 - c. Gate Position Feedback (AI)
6. Summary of Settings
- a. Maximum flow Setpoint: 5.0 MGD
 - b. Gate Position Setpoint: 946.00 ft
- D. Normal Operating Conditions at WWTP Flow less than or equal 5 MGD (This value should be adjustable by the Operator)
1. Return Activated Sludge (RAS) during normal flow condition flows to the Oxidation Ditch Splitter box where it combines with the plant influent flow and continuous to the one of the selected Oxidation Ditch channels (OXI-1 or OXI-2).

If SG-201 is "Open" then SG-202 is "Closed".	OXI-PV-01 "Open"	Interlock with SG-201
	OXI-PV-02 "Closed"	Interlock with SG-202
Operator can choose which Oxidation Ditch channel is "Set to Run" as primary.	OXI-PV-06 "Open"	Flow-passed based on FIT-110 Plant Influent Flowmeter
	OXI-PV-05 "Closed"	Interlock with OXI-PV-06
	OXI-PV-03 & 04 "Closed"	Interlock with OXI-PV-05
	SG-211 "Closed"	Interlock with SG-201
	SG-212 "Open"	Interlock with SG-202

2. Raw wastewater, after entering the system, shall pass progressively through the aerated channels of Oxidation Ditch No. 1 & 2 and then flow to the Secondary Settling Splitter Box.
- E. Peak Flow Rate or "Storm Mode" Operation, at flow above 5 MGD: During this mode of operation, the system will maintain the split flow paths for the plant influent flow (to the Oxidation Ditch Splitter Box) and RAS flow (direct feed to the Oxidation Ditch) until the plant influent flow reduces below 5.0 MGD.
1. When a significant rain event occurs the plant influent exceeds the capacity of the oxidation ditches and the rated capacity of the influent station, which is 6.0 MGD. To avoid influent sewer surcharging, some additional flow will be permitted to flow to existing EQ Tank. This is the plant's "Storm Mode" operation.
2. During this time all raw flow is directed to the Oxidation Ditch Splitter Box; and RAS flow is sent directly to the Oxidation Ditch instead of the Splitter Box. Only one Oxidation Ditch (OXI-1 Command (DO) or OXI-2) is selected by the Operator

to except the plant influent flow, while the second Oxidation Ditch receives the RAS flow. The OXI-PV-06 RAS influent to the Oxidation Ditch Splitter Box is “Closed”.

3. Local Control Panel PLC- Oxidation Ditch and SCADA OIT will monitor influent flow rate based on the signal from FT-110; when the flow reaches Setpoint of 5.0 MGD, the Storm Mode of operation will be initiated by the PLC-Oxidation Ditch.
4. During the time of “Peak” flow rate or “Storm Mode” operation, the treatment flow pattern is converted to a “contact stabilization” mode of operation. While all of the plant influent flow from the Splitter Box is diverted to the one of aeration channels, all the RAS flow is diverted to the other aeration channel and is stabilized.

If SG-201 is “Open” SG-202 is “Closed” Operator can choose which Oxidation Ditch channel is “Set to Run” as primary.	OXI-PV-01 “Open”	Interlock with SG-201
	OXI-PV-02 “Closed”	Interlock with SG-202
	OXI-PV-06 “Closed”	Flow-passed based on FIT-110 of Plant Influent Flowmeter
	OXI-PV-05 “Open”	Interlock with OXI-PV-06
	OXI-PV-04 “Open”	Interlock with OXI-PV-05
	SG-211 “Closed”	Interlock with SG-201
	SG-212 “Open”	Interlock with SG-202

5. RAS flows to the first aeration channel where it mixes with the influent wastewater and “contact” occurs. The RAS flow continues at the same flow rate as it is pumped from the RAS Pump Station. The flow from one aeration channel to another shall be achieved by the displacement of the mixed liquor circulating in each channel through the submerged port interconnecting the adjacent aeration channel. The displaced flow shall be equal to the volume of raw waste and recycled sludge introduced into the aeration system.

2.6 RETURN SLUDGE PUMPS AND FLOW METER

A. Description

1. RAS flow from the manually set telescoping valves located in the RAS/WAS Pump Station wet well will transit mixed liquor solids from the Secondary Clarifiers No. 1-3 to the RAS pumps. The RAS pumps will return settled solids from the RAS/WAS Pump Station to the Oxidation Ditch Splitter Box or the Oxidation Ditch (OXI-1 or OXI-2) tanks via a new 14” force main. The RAS magnetic flow meter **FIT-310** will monitor the return flow rate and will provide a 4-20 ma signal to speed up or slow down the pumps to achieve a programmed target return flow rate based on operator selected percent of influent flow using the plant influent flow meter **FIT-110**.
2. The sludge return pump station is submersible type pump station with two (2) pumps installed and an additional space is reserved for the third pump to be installed in the future. One pump is designed to provide the peak flow capacity with the second pump as standby pump.

B. Control Mode

1. HAND: The operator can manually operate the pumps as desired with the VFD in RAS/WAS control panel. When the H/O/A switch is placed in the “Hand” position the respective pump can be operated at any speed selected. While in Hand Mode, the Local Control Panel - PLC will not have control of the pumps.
2. AUTO: With the H/O/A selector switch in the “Auto” position the Local Control Panel – PLC or SCADA PLC will operate the pumps as follows:
 - a. Start the “Lead” Pump “ON” and run this pump in the most efficient manner to reach the target return sludge flowrate. The pump will adjust its speed to provide return sludge flow rate in response to the set percentage (50%-100%) of the plant influent flow (FIT-110). The RAS pump VFD speed will be automatically adjusted to match the set point on the Flowmeter FIT-310. For an example the flowmeter FIT-310 can be set anywhere in the range 50-100% of FIT-110.
 - b. Programming of pump speed as a percent of Oxidation Ditch influent flow (FIT-110) shall be adjustable through the Local Control Panel PLC or SCADA-PLC.

C. Interlock Summary

1. Low water Level in RAS/WAS wet well will Stops the pump operation.

D. Alarm Summary

1. Motor Run Status
2. VFDs (if used) - control, overload, and status feedback.
3. All Alarms, Faults
4. Levels (if used) - digital and analog devices.
5. Pressures (if used) – digital and analog devices.
6. Loss of signal from the flowmeter FIT-110 or FIT-310

E. Summary of Settings

1. Select lead-lag, and stand-by (future) pump.
2. On the RAS Pumps Control Screen select target RAS flow rate as percent of influent plant flow (FIT-110).
3. The “Duty” and “Standby” pumps shall alternate.

F. Pump Control Panel Display

1. Pump Mode – H-O-A
2. RAS Pump Status – On-Off
3. Vendor Panel Pump Alarms
4. Radar Level (LIT-310)
5. RAS flow, GPM
6. RAS as % plant influent flow (FIT-110)

2.7 WAS METER AND WAS MOTOR OPERATED VALVE TIME CYCLE

A. Description

1. A portion of the secondary return sludge will be wasted to the aerobic digesters to maintain a level of MLSS in the aeration tanks. The PLC, waste sludge motor operated valve and WAS flowmeter (**FIT-901**) will provide a time-based volume of sludge wasting sequence to the Aerobic Digesters. The PLC will control the motor-operated WAS plug valve to cycle “Open” and “Close” for the specified time period set by the Operator. A magnetic flow meter will monitor the waste sludge flow rate and provide 4-20 mA signal to be used by the PLC to automatically calculate the volume of sludge wasted per each “Open-Close” cycle (gal per time period) and total the sludge wasted during a 24-hrs period in gallons per day and as well as a percent of influent flow (**FIT-110**). The waste sludge valve will be controlled by the PLC in the RAS/WAS control panel.

B. Control Mode

1. **HAND:** The operator can manually operate the valve as desired. When the H/O/A switch is placed in “Hand” position, the valve position can be manually adjusted. While in Hand Mode, the PLC will not have control of the valve.
2. **AUTO:** With the H/O/A selector switch in the Auto position the PLC will operate the valve as follows:
 - a. The duration of time for sludge wasting cycle shall be adjustable with the PLC and will utilize the waste sludge flowmeter to monitor volume of sludge wasted.
 - b. The following table shall be used as an example to program the waste sludge set points for the indicated influent flowrate based on a 24-hr or 6-hour wasting sludge time-cycle period. The WAS control valve shall be adjusted on a timed basis to achieve the target WAS flowrate.

Plant Flow MGD	Rate, % Influent Flow	WAS flow, GPM	
		Time of cycle 24-hrs	Time of cycle 6-hrs/day
0.5	1.5%	5.2	21
0.5	5%	17.4	69
1.00	1.5%	10.42	42
1.00	5%	35	139
1.5	1.5%	15.6	62.5
1.5	5%	52.1	208
2.0	1.5%	21	83
2.0	5%	69.4	278
2.5	1.5%	26.04	104
2.5	5%	87	347
3.0	1.5%	31.25	125
3.0	5%	104.2	417
3.5	1.5%	36.46	146

3.5	5%	122	486
4.0	1.5%	42	167
4.0	5%	139	556
4.5	1.5%	47	187.5
4.5	5%	156	625
5.0	1.5%	52	208
5.0	5%	174	694
5.5	1.5%	52	229
5.5	5%	191	763
6.0	1.5%	62.5	250
6.0	5.0%	208	833

C. Interlock Summary

1. None

D. Alarm Summary

1. Valve Failure
2. Loss of signal from influent meter or WAS meter

E. Summary of Settings

1. WAS flow (gpm), 24-hr
2. WAS flow (gpm), 6-hr

F. PLC Monitoring Display

1. Valve Mode : Hand/Off/Auto
2. WAS Valve Status: Open/Closed
3. Valve Alarms
4. Duration Set Points for WAS valve change cycles: Time Open /Time Close
5. Flow table(from above)
6. % set point of plant influent flow (FIT-110)
7. Frequency of WAS Valve Open/Close cycle per day.

2.8 SECONDARY CLARIFIERS (aka Final Clarifiers)

A. Description

1. There are total of three (3) Secondary Clarifiers. The clarifier sludge scraper mechanisms run continuously when online and serve to collect sludge to their individual sludge take-off (RAS) suction lines.
2. The Local SCADA PLC panel shall monitor a minimum of five (5) pairs of hardwired contacts for status and alarms monitoring per each Secondary Clarifier. Refer to Specification 464324, Final Settling Tanks Mechanism.

B. Control Mode

1. **HAND:** When the H-O-A switch for one of the scraper mechanisms is placed in the Hand position, the manual operators in the local combination motor starter will be used to control the mechanism. While one of the mechanisms is in Hand mode, commands from the PLC are ignored.
2. **AUTO:** With the selector switch in the Auto position, the mechanisms will ignore the local combination starter operators and be controlled from the PLC. While in Auto mode, the clarifier scraper will start up automatically upon restoration of motor power, for instance following utility power failure and transfer to the emergency generator.
3. The PLC shall be able to adjust the slide gates in order to reach the following positions and split the flow among the three (3) Final Settling Tanks. For the Proportional Flow Mode:

Influent Total Flow, MGD	FC # 1 Flow, MGD	Weir # 1 Head (ft)	FC # 2 Flow, MGD	Weir # 2 Head (ft)	FC #3 Flow, MGD	Weir # 3 Head (ft)	Weir Differen.
0.1	0.05	0.0138	0.05	0.0138	0.0038	0.0010	-
0.2	0.06	0.0154	0.06	0.0154	0.09	0.0242	0.0088
0.3	0.08	0.0231	0.08	0.0231	0.13	0.0363	0.0132
0.4	0.11	0.0308	0.11	0.0308	0.18	0.0485	0.0176
0.5	0.14	0.0385	0.14	0.0385	0.22	0.0606	0.0220
0.6	0.17	0.0463	0.17	0.0463	0.26	0.0727	0.0264
0.7	0.20	0.0540	0.20	0.0540	0.31	0.0848	0.0308
0.8	0.22	0.0617	0.22	0.0617	0.35	0.0969	0.0352
0.9	0.25	0.0694	0.25	0.0694	0.40	0.1090	0.0396
1.0	0.28	0.0771	0.28	0.0771	0.44	0.1211	0.0441
1.1	0.31	0.0848	0.31	0.0848	0.48	0.1333	0.0485
1.2	0.34	0.0925	0.34	0.0925	0.53	0.1454	0.0529
1.3	0.36	0.1002	0.36	0.1002	0.57	0.1575	0.0573
1.4	0.39	0.1079	0.39	0.1079	0.62	0.1696	0.0617
1.5	0.42	0.1156	0.42	0.1156	0.66	0.1817	0.0661
1.6	0.45	0.1233	0.45	0.1233	0.70	0.1938	0.0705
1.7	0.48	0.1311	0.48	0.1311	0.75	0.2059	0.0749
1.8	0.50	0.1388	0.50	0.1388	0.79	0.2181	0.0793
1.9	0.53	0.1465	0.53	0.1465	0.84	0.2302	0.0837
2.0	0.56	0.1542	0.56	0.1542	0.88	0.2423	0.0881
2.1	0.59	0.1619	0.59	0.1619	0.92	0.2544	0.0925
2.2	0.62	0.1696	0.62	0.1696	0.97	0.2665	0.0969
2.3	0.64	0.1773	0.64	0.1773	1.01	0.2786	0.1013
2.4	0.67	0.1850	0.67	0.1850	1.06	0.2907	0.1057
2.5	0.70	0.1927	0.70	0.1927	1.10	0.3029	0.1101
2.6	0.73	0.2004	0.73	0.2004	1.14	0.3150	0.1145
2.7	0.76	0.2081	0.76	0.2081	1.19	0.3271	0.1189

2.8	0.78	0.2159	0.78	0.2159	1.23	0.3392	0.1233
2.9	0.81	0.2236	0.81	0.2236	1.28	0.3513	0.1278
3.0	0.84	0.2313	0.84	0.2313	1.32	0.3634	0.1322
3.1	0.87	0.2390	0.87	0.2390	1.36	0.3755	0.1366
3.2	0.90	0.2467	0.90	0.2467	1.41	0.3877	0.1410
3.3	0.92	0.2544	0.92	0.2544	1.45	0.3998	0.1454
3.4	0.95	0.2621	0.95	0.2621	1.50	0.4119	0.1498
3.5	0.98	0.2698	0.98	0.2698	1.54	0.4240	0.1542
3.6	1.01	0.2775	1.01	0.2775	1.58	0.4361	0.1586
3.7	1.04	0.2852	1.04	0.2852	1.63	0.4482	0.1630
3.8	1.06	0.2930	1.06	0.2930	1.67	0.4604	0.1674
3.9	1.09	0.3007	1.09	0.3007	1.72	0.4725	0.1718
4.0	1.12	0.3084	1.12	0.3084	1.76	0.4846	0.1762
4.1	1.15	0.3161	1.15	0.3161	1.80	0.4967	0.1806
4.2	1.18	0.3238	1.18	0.3238	1.85	0.5088	0.1850
4.3	1.20	0.3315	1.20	0.3315	1.89	0.5209	0.1894
4.4	1.23	0.3392	1.23	0.3392	1.94	0.5330	0.1938
4.5	1.26	0.3469	1.26	0.3469	1.98	0.5452	0.1982
4.6	1.29	0.3546	1.29	0.3546	2.02	0.5573	0.2026
4.7	1.32	0.3623	1.32	0.3623	2.07	0.5694	0.2070
4.8	1.34	0.3700	1.34	0.3700	2.11	0.5815	0.2115
4.9	1.37	0.3778	1.37	0.3778	2.16	0.5936	0.2159
5.0	1.40	0.3855	1.40	0.3855	2.20	0.6057	0.2203
5.1	1.43	0.3932	1.43	0.3932	2.24	0.6178	0.2247
5.2	1.46	0.4009	1.46	0.4009	2.29	0.6300	0.2291
5.3	1.48	0.4086	1.48	0.4086	2.33	0.6421	0.2335
5.4	1.51	0.4163	1.51	0.4163	2.38	0.6542	0.2379
5.5	1.54	0.4240	1.54	0.4240	2.42	0.6663	0.2423
5.6	1.57	0.4317	1.57	0.4317	2.46	0.6784	0.2467
5.7	1.60	0.4394	1.60	0.4394	2.51	0.6905	0.2511
5.8	1.62	0.4471	1.62	0.4471	2.55	0.7026	0.2555
5.9	1.65	0.4548	1.65	0.4548	2.60	0.7148	0.2599

4. For future functions, the PLC shall be able to control the proportional flow mode of a total of four (4) gates.

C. Interlocks: None

D. Alarm Summary

1. Scraper Motor Overload Fault
2. High Torque Warning
3. High Torque Shutdown Alarm

E. SCADA Status Monitoring (Digital Inputs)

1. For each of the mechanisms display the following:
 - a. Auto Mode

b. Running Status

F. Control Points

1. Mechanism Start
2. Mechanism Stop

2.9 TERTIARY TREATMENT AND TERTIARY LIFT STATION

A. Tertiary Filtration:

1. The Disk Filter operation will be managed by an automated control system. The controller will be an Allen Bradley CompactLogix PLC, or approved equal. Refer to Specification 46133, Automatic Backwash Discfilter Equipment.
2. The PLC will be equipped with an embedded 10/100 Base-T Ethernet/IP Port as well as a USB programming port.
3. The control system shall be supplied with one Operator Interface. The Operator Interface shall:
 - a. Communicate with the PLC via 10/100 Base-T Ethernet port.
 - b. Display text and graphics objects.
 - c. Allow operator setpoint entry and provide system status display.
 - d. Be a color touchscreen with a minimum size of ten (10) inch diagonal and mount in the control panel door.
 - e. Be an Allen Bradley 2711R-T10T or approved equal.

B. Tertiary Filter Effluent Pump Station

1. Controls package for the Tertiary Filter Lift Station is provided by the manufacturer, refer to specification Refer to Section 432513. The flow from the Tertiary Filter Lift Station is conveyed to the UV Disinfection Tank.
2. Pumping system is furnished by the vendor with a PLC based control panel, programmed for automatic and local manual operation. System Integrator to interface the control panel to plant SCADA via Ethernet for monitoring of pump (x3) statuses, wet well level & discharge pressure signals and remote manual control.
3. Influent Raw Wastewater Pump Station is equipped with a total of three (3) submersible pumps, ultrasonic level transmitter and floats for back-up control and high-level alarm, and a pressure gage.

C. Control Mode

1. HAND: The operator can manually start and stop the pumps as desired at the pumps control panel or remotely at SCADA OIT. While in Hand Mode, the pumps will be controlled directly by the VFDs.
2. AUTO: With the H/O/A selector in "Auto" the new Influent Pumps Control Panel will operate the four new pumps in Lead Pump-lag Pump-standby Pump fashion. The fourth pump shall be used in a standby mode. The System Integrator (SI) shall program the new PLC to allow the inclusion of the fifth pump in the future. Automatic alternation of the pumps shall be utilized to equalize run times. Duty and Standby pumps shall alternate.

3. Alarm Summary
 - a. Pump Fault
 - b. High water alarm
 - c. HH Water Alarm – EQ flow On
4. Monitoring Parameters
 - a. Motor Run Status
 - b. VFDs (if used) - control, overload, and status feedback.
 - c. Levels (if used) - digital and analog devices.
 - d. Pressures (if used) – digital and analog devices.
 - e. Flow (if used) – digital and analog devices.
 - f. All Alarms, Faults
5. Summary of Settings
 - a. Lead Pump on elevation (to be field determined)
 - b. Lag Pump 2 on elevation 917.50 (to be field verified)
 - c. Lag Pump 3 on elevation 919.00 (to be field verified)
 - d. High Water Alarm elevation 920.50 (to be field verified)
 - e. Lag Pump 4 on elevation 921.00 (to be field verified)
 - f. All off elevations 913.00 (to be field verified)
6. Control Point
 - a. Pumps 1- 4 Run Commands
 - b. Pumps 1- 4 Speed References

2.10 UV DISINFECTION

- A. The operation of the UV3000Plus™ is managed at the SCC by a PLC-based controller which continuously monitors and controls the system functions. The PLC shall be a CompactLogix as manufactured by Allen Bradley.
- B. The PLC will communicate with the SCADA system via Ethernet/IP and pass along any and all relevant system values. See specification Section 466600 for a complete list.

2.11 SLUDGE TRANSFER LIFT STATION (AEROBIC DIGESTERS 1-3)

- A. Description: The Sludge Transfer Lift Station is located in the building, Aerobic Digester No. 1-3 area. There are two (2) progressive cavity pumps, two (2) grinders and a total of six (6) motor motor-operated plug valves. The remote motor-operated valves control station is located on the ground floor of the Sludge Transfer Lift Station along with the Grinder and Pump Control Panel. Refer to Specifications 432110, Progressive Cavity Pump and 462433 Sewage Grinder for the control's description.
- B. The Systems Integrator shall provide a PLC control panel to coordinate the control of the new equipment in the Sludge Transfer Lift Station. The control panel shall contain hardware to achieve the functions outlined below; at a minimum, the hardware shall be:
 1. Allen-Bradley CompactLogix PLC with integrated Ethernet/IP port.
 2. Panelview Plus full color touchscreen HMI, 10" min.
 3. 10/100 Base-T Ethernet Switch with one (1) fiberoptic port, min.

4. Analog and Digital I/O modules to control the equipment in the station.
- C. The Electrical Contractor shall provide the Ethernet IP connection to SCADA for the Sludge Transfer Pumps and Dewatering Feed Pumps. Coordinate with the System Integrator to determine physical media (fiber optic vs. Cat 6 copper).
- D. PLC control panel shall interface with the signals present in the equipment manufacturer's local controllers that include:
 1. Sludge Grinder #1 & #2 combination motor controllers
 2. Sludge Transfer Pump #1 & #2 combination motor controllers
 3. Motor Operated Valves STL-PV-02, -04, -05, -06, -07 and -08 actuators
- E. Sludge Transfer Pump motor controllers will have Manual/Auto selector switches that shall allow running from the SCADA panel in Auto mode. In the Manual mode, the sludge transfer operation shall be run only from the combination motor controller.
 1. Auto mode of operation is based on choosing flow path either for Grinder #1 and Pump #1; or Grinder #2 and Pump #2 with respect to the motor operated valves on the pump suction and discharge side in the "Open" position.
 2. Interlocks are present between Motor Operated Valves STL-PV-02, -04, -05, -06, -07 and -08 (PLC control panel) and the respective Grinder-Pump pair operation.
 - a. Manual mode of operation shall allow operator to select the respective motor operated valves – for Grinder #1/2 and Pump #1/2. In the Manual mode each motor operated valve, Grinder, and Pump will be started manually.
 3. Alarms
 - a. Pump running dry.
 - b. Pump Discharge Over pressure.
 - c. Motor overload
 - d. If a Grinder fails to run, it shall stop the Pump operation and annunciate an alarm.
 - e. If a Pump fails to run, it shall stop the Grinder and annunciate an alarm.

2.12 SLUDGE FEED PUMPS TO DEWATERING SCREW PRESS

- A. Description: Sludge feed system to the dewatering screw press includes grinders (x2) and progressive cavity pumps (x2). The Local Control Panel for the pumps and grinders is furnished by the equipment supplies. Refer to Specifications 432110, Progressive Cavity Pump and 462433 Sewage Grinder for the control's description.
- B. IP Flowmeter value from Screw Press Control Panel displayed locally.
- C. Local Control Panel shall be equipped with Local/Remote and Auto/Hand modes selector switches.
- D. Interlocks: Grinder #1, Pump #1, and Screw Press; or Grinder #2, Pump #2, and Screw Press.
- E. When selector switches are set to Auto and Remote at the Grinder-Pump Local Control Panel, it enables the Grinder-Pump pair and Screw Press to run together in the Automatic mode of

operation from the Screw Press HMI Screen or SCADA OIT. The flowmeter controller located in the Sludge Dewatering Building on the Dewatering Feed Pump force main to the Screw Press will control the VFDs on the feed pumps.

1. Note: There are only manual valves installed on the pump suction and discharge piping. The flow path shall be set by opening corresponding valves on the suction and discharge piping prior to Grinder-Pump pair starting.
- F. In “Manual” mode, the Grinder, Pump and Screw Press will be started manually from the HMI or SCADA OIT.
- G. Dewatering Feed Pump VFDs are included in the Pump Control Panel.
- H. Dewatering Feed Pump VFDs are included in the Pump Control Panel
- I. The “Local” mode of operation is mainly for the equipment maintenance, it causes the Grinder-Pump pair to run only from the Local Control Panel.
- J. Alarms
1. If a Grinder or Pump fails to run, it triggers an alarm and shuts down the other part of the pair and the Screw Press.
 2. If the Screw Press stops running, it shall stop the respective Grinder and Pump operation.
- K. Pump Alarms
1. Pump running dry.
 2. Discharge Over pressure.
 3. Motor overload.
 4. If a Grinder fails to run, it shall stop the Pump operation and annunciate an alarm.
 5. If a Pump fails to run, it shall stop the Grinder and annunciate an alarm.

2.13 DEWATERING EQUIPMENT

- A. The Screw Press shall be provided by the screw press manufacturer with an Allen Bradley PLC. Full application software will be generated by the Screw Press manufacturer to operate the dewatering system.
- B. External SCADA system connection shall be over Ethernet and allow the monitoring of status and alarms for all system components available at the local control system. See specification Section 467331 for full list of signals to be sent to the SCADA system.

2.14 BLOWERS

- A. External SCADA system connection shall be over Ethernet and allow the monitoring of status and alarms for all system components available at the local control system. See specification Section 44334 for full list of signals to be sent to the SCADA system.

- B. Blower speed/output for each energized blower package shall be set by the Operator via the MCP

END OF SECTION 406196

SECTION 407000 – FIELD-MOUNTED INSTRUMENTATION EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. P&ID Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SECTION INCLUDES

- A. The general requirements of the instrumentation equipment.

1.3 RELATED SECTIONS

- A. P&ID Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to work of this section.
 - 1. Division 26 – Electrical
 - 2. Divisions 35 – Water Way and Marin Construction
 - 3. Division 43 – Process Liquid Handling
 - 4. Division 46 – Wastewater Equipment

1.4 REFERENCES

- A. ANSI/NFPA 70 National Electrical Code (NEC)
- B. Instrument Society of America (ISA)
- C. Underwriters Laboratories (UL): Applicable listings

1.5 SUBMITTALS

- A. Submit under provisions of Division 1 - General Requirements.
- B. Complete and detailed system schematic drawings showing all components and the pneumatic/hydraulic and electrical point connections of each system together with a description of the operation of the system and equipment.
- C. Instrumentation equipment specifications, outlined dimension drawings, and wiring and piping diagrams for each item of equipment. Duplicate equipment may be covered by one set of literature.
- D. The submittal shall be organized in a logical manner and have a schematic ladder diagram for each system.

1.6 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing Products specified in this Section with minimum five years documented experience is required.

1.7 REGULATORY REQUIREMENTS

- A. Conform to requirements of ANSI/NFPA 70.
- B. Furnish products listed and classified by Underwriters Laboratories, Inc. as suitable for purpose specified and shown.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Furnish and install the instrumentation and appurtenances required for this project.
- B. Electronic instruments shall be solid state and the manufacturer's latest design. Equipment shall use a 4-20 mA DC standard process signal unless otherwise specified. Signals from measuring systems and analyzers with millivolt outputs shall be immediately raised and converted to 4-20 mA DC signals for transmission.
- C. All field instruments shall be of the same manufacturer and general model type.
- D. Equipment to be installed in hazardous locations shall be listed for the location. Refer to electrical drawings for area classifications.

2.2 MAGNETIC METERS

- A. Acceptable Manufacturers:
 - 1. Endress & Hauser
 - 2. Brooks
 - 3. Krohne
 - 4. Or approved equal
- B. Each meter shall include a magnetic metering tube, removable electrode, a signal converter with local indicator, flow totalizer and listed specials.
- C. Metering tube:
 - 1. The magnetic flow meter shall operate on DC voltage in which the voltage induced is directly proportional to the volumetric flow through the meter.
 - 2. The metering tube shall be constructed of 304 stainless steel with 150 lb. ANSI flange for connections. The meter liner shall be Teflon.
 - 3. By nature of its design, the meter shall feature zero stabilization with no drift, low power consumption and require no field calibration unless one of the control PC boards is replaced.
 - 4. The meter and housing shall be capable of submergence and shall meet NEMA 6P standards, as a minimum. Refer to Special Provisions.

5. When required by the Special Provisions, especially on intermittent flows, the meter shall be provided with positive zero return.
6. Grounding of the meter shall be accomplished by the Manufacturer's standard method for use on lined or non-conductive pipe. Grounding rings shall be of Type 316 stainless steel.
7. The meter shall run on a 115-volt, 60 Hz, single phase power supply, which shall be provided by the Electrical Contractor.
8. The meter shall be accurate to plus or minus 0.5% of full scale under the specified operating conditions. Voltage or frequency fluctuations in the power supply of plus or minus 10% shall not produce an error of more than plus or minus 0.5% of full scale.

D. Electrodes

1. The electrodes or electrode cartridge shall be Type 316 stainless steel and shall be capable of being removed in the field for cleaning with the meter on-line, under pressure and without recalibration. This shall be accomplished by inserting the electrode through a corporation cock or valved assembly.
2. The electrode housing shall also be made of 316 stainless steel.
3. The electrode shall be screwed into the end of the valve fitting to provide a positive seal rated at the same pressure as the meter.
4. The electrode will be fastened to the valve or meter by a chain of a sufficient length that will allow cleaning but prevent damage due to accidental dropping.

E. Signal converter – transmitter:

1. The signal converter-transmitter shall be micro-processor based and shall be a product of the metering tube manufacturer. Each signal converter transmitter shall work with any of the flow meters provided. The unit shall be field scalable and shall require no zero-point adjustment. The unit shall be provided with self- diagnostics PC card, automatic data checking and data retention for a minimum of 10 years.
2. The signal converter-transmitter shall be wall mounted within 50 ft. of the flow meter. The signal converter-transmitter enclosure shall have a NEMA 4 minimum.
3. The signal converter-transmitter shall amplify and convert the DC input signal from the flow meter into a 4-20 ma DC signal proportional to the volumetric flow through the meter.
4. The DC signal shall drive a integral flow indicator.
5. The local flow indicator shall indicate flow in gallons per minute (GPM) and totalize.
6. The signal converter-transmitter shall run on a 115-volt, 60 Hz, single phase power supply, which shall be provided by the Electrical Contractor.
7. The signal converter-transmitter shall be accurate to plus or minus 0.5% of full scale under the specified operating conditions. Voltage of frequency fluctuations in the power supply of plus or minus 10% shall not produce an error of more than plus or minus 0.5% of full scale.

2.3 ULTRASONIC TYPE LEVEL DETECTOR

A. Acceptable Manufacturers:

1. Endress & Hauser

2. Bristol Babcock
3. Magnatrol
4. Or approved equal

B. Level Sensor:

1. Range: 0 – 40 feet (or as shown in the Instrument Schedule, paragraph 3.6)
2. Operating Frequency: 30 kHz
3. Sample Rate: 2 kHz
4. Mounting: Direct bracket mounting (or as shown)
5. Electronic Housing: Enameled aluminum
6. Operating Pressure: 15 psig, maximum
7. Standard Operating Temperature: -4°F to +140°F
8. Temperature Compensation: Silicon temperature sensor located behind acoustic membrane.
9. Power Supply: Transmitter provides power input to sensor.
10. Cable: As recommended by vendor
11. Sensor shall be capable of submergence.

C. Level Indicating Transmitter:

1. Enclosure: NEMA 4X, minimum
2. Power Requirements: 115 VAC, 60 Hz, 6 VA
3. Operating Temperature: -5°F to +160°F
4. Accuracy: 1% of span, typical
5. Display: 4-digit LCS meter, scalable to user's engineering units
6. Output: 4-20 mA DC, direct acting into 0-500 ohms
7. Linearity: 1% of span
8. Repeatability: 0.1% of span

2.4 FLOAT SWITCHES

- A. The level detecting devices shall be mechanical activated wide angle to prevent activation with surface turbulence.
- B. The float switch shall have a 20A rating at 120 VAC. The float switch shall close on rising level. Each float switch shall have a normally open and normally closed contact.
- C. Mounting column shall be 316 SS long enough to terminate in a field-mounted junction box with terminal strips provided for power and float switch connections.
- D. The length of the column and cabling shall be sized by the contractor.
- E. The floats shall be manufactured by SJE Pump Master or approved equal.

2.5 INSTRUMENT POWER

- A. Provide instruments to operate on 105-135 VAC RMS at 60 Hz power supplies.

- B. Provide regulators and power supplies with the instrument required for compliance. Electrical isolation shall be provided between power supplies and connected instrument systems. Equipment which requires voltage regulation of less than ± 10 percent variation shall be provided with constant voltage transformers.
- C. All panels containing solid state electronic equipment shall be equipped with line voltage surge suppressors to protect the equipment from damage due to electrical transients induced in the interconnecting lines from lightning discharges or nearby electrical devices.
- D. The surge suppressors shall be of the Plugtrab sleeves as manufactured by Phoenix Contact, or approved equal, and mounted on a DIN rail.

2.6 SIGNAL LINE TRANSIENT PROTECTION

- A. All signal lines for solid-state electronic equipment shall be equipped with line voltage surge suppressors to protect the equipment from damage due to electrical transients induced in the interconnecting lines from lightning discharges or nearby equipment.
- B. This shall include, but not be limited to digital inputs, analog inputs, analog outputs, flow transmitters and level transmitters. The signal line transient protection shall be provided on any signal lines which are outside of the building structure housing the area control panel and RTU electronic equipment.
- C. The signal line transient protection shall include gas discharge tubes, varistors, and suppressor diodes.
- D. The unit shall be Phoenix terminal block type Plugtrab Model UFBK 2/2, UFBK 2-PE, UFBK2-PE/1, or approved equal.
- E. Provide lightning protection termination for all digital and analog signal plus a minimum of 10 percent spares per panels.
- F. Terminal block shall be DIN rail type, mounted in the vertical position.

2.7 TRANSIT TIME METER (DOPPLER TYPE FLOW METER)

- A. Approved Manufacturers:
 1. Flexy America Corporation, Edgewood, NY 11717; Phone: (631)492-2300
salesus@flexim.com
 2. Or approved equal
- B. Technical Data
 1. Measuring principle: Transit time difference correlation principle
 2. Quantities of measurement: Volume flow, mass flow, flow velocity, thermal energy flow
 3. Transmitter processor: 32 bit or greater
 4. Flow velocity: 0.03 to 82 ft/s
 5. Repeatability: 0.15% of reading ± 0.03 ft/s

6. Calibrated transducer accuracy:
7. $\pm 1\%$ of reading, ± 0.03 ft/s with certificate of calibration
8. Gaseous and solid content: $< 10\%$
9. The meter shall meet AWWA C-750-16

C. Transducers

1. Operating temperature: -30°F to $+120^{\circ}\text{F}$
2. Built in RTDs for temperature compensation per ASME MFC 5M
3. Coupled to pipe with permanent coupling pads
4. NEMA 4X enclosure
5. Material: 316 Stainless Steel
6. Protective cap 316 Stainless Steel
7. Hazardous area classification: NA

2.8 MAGNETIC FLOW METERS (LIQUID/SOLIDS FLOW)

A. Acceptable Manufacturer:

1. Endress & Hauser
2. Sparling Instruments Company, Inc.
3. Ficher & Porter Company
4. Krohne America Inc.
5. Danfoss
6. Or approved equal

B. Magnetic Flowmeters: Electro-magnetic induction pulsed DC type and producing a signal directly proportional to the liquid rate of flow with zero-point stability. Meters shall have ISO standard lay length.

C. Provide magnetic flowmeters such that the ratio of flow velocity to reference signal generated is identical for all sizes so that all meters are compatible with secondary readout instruments without circuit modifications.

D. Meter Housing: Splash proof and weather resistant, and capable of withstanding 30 feet of submergence

E. Grounding Rings: Provide corrosion resistant metallic grounding gaskets or rings on the upstream and on the downstream ends of the meter.

F. End Connections: Flanged type, unless otherwise specified or shown

G. Electrodes: Zirconium, tantalum, or 316 S.S.

H. Connections: Provide connections for signal and external power supply.

I. Magmeter Liners shall be Teflon for sludge applications, neoprene for sewage applications and polyurethane for potable water applications.

J. Transmitters: Furnish meters with integral transmitters, unless otherwise stated.

- K. Rangeability: 100:1, or greater
- L. Metering System Accuracy: Within $\pm 1\%$ of rate for a flow velocity of 3 to 31 fps including the signal converter and readout instrumentation.
- M. Calibration: Hydraulically calibrate meters at the manufacturer's facility against a master meter traceable to the National Institute of Science and Technology (NIST). Furnish a computer printout of the calibration data with each meter. Include a calibration curve.
- N. Signal Converter Cable: Include signal cable for connecting the meters for indicating signal converters for magmeters where mounted remotely to the meters.
- O. Signal Converter
 1. Input Impedance: 10^{10} ohms, or greater
 2. Electronics: Microprocessor controlled
 3. Provide magmeters with bi-directional flow capabilities.
 4. Include empty pipe detection and low flow cut-off.
 5. Output: 4-20 mA DC into 0 to 900 ohms
 6. Power Supply: 120 volts, single phase
 7. Calibration: Capable of operation throughout its expected life under normal use without calibration
 8. Display: Indication of instantaneous and totalized flow

2.9 MISCELLANEOUS

- A. After a power interruption, equipment shall resume normal operation without manual resetting when power is restored.
- B. Local manual operation shall be provided for emergency situations or to facilitate maintenance and repair.
- C. Signals transmitted to remote equipment and pacing signals for feeders, samplers, pumps, and similar equipment shall be provided with isolators and boosters.
- D. Special cables required to connect system components shall be supplied by the meter manufacturer.
- E. Pressure piping, including drains, air supply, and signal, shall be copper with soldered or compression fittings sized as recommended by the meter manufacturer. Piping shall be neatly and accurately run in straight lines and concealed where possible. Piping shall slope per ISA standards where applicable.
- F. Transmitters shall be indicating type or have local indicators with direct reading, unless stated otherwise, and shall output a 4-20 mA DC signal into a minimum 500 ohm load.
- G. Differential pressure transmitters shall have 5-valve, equalizing manifolds.
- H. Differential pressure transmitters shall be connected to high and low pressure taps on the primary device by two 1/2-inch valved copper lines.

- I. Provide square root extractors on differential pressure transmitters.
- J. Control trip alarms shall be fully adjustable by means of knobs with calibrated dials and shall have isolated contacts.
- K. Free standing instrument panels, cubicles, and consoles, unless specifically stated otherwise, shall be installed on a 4-inch thick concrete pad.
- L. Panels, cubicles, consoles, and enclosures shall be in conformance with the detailed equipment specifications. Color and finish will be selected by Engineer.
- M. Isolators shall be used for sampler, chemical pacing, and remote instrumentation signals to increase loop security and to facilitate field wiring.
- N. Desiccant used to protect equipment during shipment shall be non-corrosive.
- O. End connections for valves and metering devices shall be as shown.
- P. Signal wire shall conform to the equipment and manufacturer's recommendations if it exceeds the minimum requirements specified in Division 16 and shall be shielded with twisted pairs and installed in rigid galvanized steel conduit containing signal wiring only. Wiring and conduit shall be provided in accordance with Division 26.
- Q. All components provided, both field and panel mounted, shall be provided with permanently mounted nametags. Panel mounted tags shall be plastic; field mounted tags shall be stamped stainless steel.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify location of cabinets as shown on Plans.

3.2 INSTALLATION

- A. Install in accordance with manufacturers requirements.
- B. Install Work in accordance with standards required by authority having jurisdiction.
- C. Provide flexible conduit drip legs in power and signal connections to instruments.
- D. Touch-up minor damaged surfaces caused during installation. Replace damaged components as directed by Engineer.

3.3 MANUFACTURER'S FIELD SERVICES

- A. Prepare and start systems under provisions of Division 1 – General Requirements.

- B. Furnish a service representative of the system manufacturer to check the installation before operation and to supervise field testing.
- C. Service representative to submit 3 copies of a signed statement addressed to Owner stating that the system has been properly installed, satisfactorily tested, and is in satisfactory operating condition.
- D. Include one man-day for every eight instruments installed.

3.4 ADJUSTING

- A. Adjust work under provisions of Division 1 - General Requirements.

3.5 DEMONSTRATION

- A. Provide systems demonstration under provisions of Division 1 – General Requirements.
- B. Demonstrate and instruct Owner on unit operation. Describe unit limitations.

3.6 INSTRUMENT SCHEDULE

A. The following list of instruments are required. Unless otherwise noted, one instrument is required.

DESCRIPTION	TYPE	MEDIA	OPERATING RANGE	POWER	SUBMERGED		EXPLOSION PROOF (XP)	OUTPUT	FURNISHED BY	NOTES
					Y / N	Y / N				
Influent PS level sensor	Radar Transducer	Raw wastewater	0-11.5 ft	24 VDC loop	No	No	Yes	4-20 mA	Contractor	LT-101
Headworks Building	Mag-meter	Raw wastewater	0-12 MGD	120 VAC	No, Installed on 18" FM		Yes	4-20 mA	Existing	FIT-110
Headworks Building Screen Channel	Ultrasonic Level	Raw wastewater	0-3 ft	24 VDC loop	No	No	Yes	4-20 mA	Screen Manufacturer	(LT-110) See Section 462116
Oxidation Ditch Splitter Box	Radar Transducer	Primary Effluent & RAS	0-11.5 ft	24 VDC loop	No	No	Yes	4-20 mA	Contractor	LT-201
Oxidation Ditch (OD) - DO sensor	Luminescence	Activated sludge	0-10 mg/l	120 VAC	12 ft		No	4-20mA	Oxidation Ditch Manufacturer	DO-201 See Section 465361
Final Clarifier Splitter Box	Radar Transducer	Secondary MLSS effluent	0-4.5 ft	24 VDC loop	No	No	Yes	4-20 mA	Contractor	LT-301
Tertiary Filter PS	Ultrasonic Level	Cleaned Plant Effluent	0-14.5 ft	24 VDC loop	No	No	No	4-20 mA	Contractor	LT-601
Parshall Flume	Ultrasonic Level	Cleaned Plant Effluent	0-9.75 ft	24 VDC loop	No	No	No	4-20 mA	Parshall Flume Manufacturer	(LT-110) See Section 467400
RAS/WAS Sludge Wet Well Level Transmitter	Radar Level	Activated sludge	0- 8.67 ft	24 VDC loop	No	No	Yes	4-20 mA	Contractor	LT-310
RAS Meter – 14"	Mag-meter	Activated sludge	0 – 6 MGD	120 VAC	No, installed on the FM		No	4-20mA	Contractor	FIT-310
WAS Meter – 4"	Mag-meter	Activated sludge	0 – 4 MGD	120 VAC	No, installed on the FM in Sludge Transfer PS		No	4-20mA	Contractor	FIT-901

Sludge Dewatering Feed - 4"	Mag-meter	Digested Sludge	0-500 gpm	120 VAC	No, installed in the Sludge Dewatering Building	No	4-20mA	Contractor	FIT-1001
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END OF SECTION 407000

SECTION 409600 – PLC & SCADA CONTROL SYSTEM

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, and Division-1 Specification sections apply to work of this section.
- B. This Section covers includes the general requirements for furnishing, installing, programming, adjusting, testing, documenting, and commissioning of the complete and operational SCADA and PLC based control system that is part of the Sunbury WWTP control system.
- C. Related Sections:
 - 1. Section 260010 – General Requirements
 - 2. Section 260020 – Demolition
 - 3. Section 260519 – Conductors
 - 4. Section 260526 – Grounding
 - 5. Section 409601 – Control Panel for Exterior Locations
 - 6. Section 409602 – Control Panel for Interior Locations

1.2 REFERENCE

- A. The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.
 - 1. IEEE C62.41 Surge Voltages in Low-Voltage AC Power Circuits
 - 2. National Electrical Manufacturers Association (NEMA)
 - 3. NEMA 250 Enclosures for Electrical Equipment (1000 Volts Maximum)
 - 4. NEMA AB 1 Molded Case Circuit Breakers and Molded Case Switches
 - 5. NEMA ICS 1 Industrial Controls and Systems
 - 6. NEMA ICS 2 Industrial Control Devices, Controllers and Assemblies
 - 7. NEMA ICS 4 Industrial Control and Systems: Terminal Blocks
 - 8. NEMA ICS 6 Enclosures for Industrial Control and Systems
 - 9. NEMA ST1 Standard for specialty transformers
 - 10. National Fire Protection Association (NFPA)
 - 11. NFPA 70 National Electrical Code
 - 12. NFPA 780 Installation of Lightning Protection Systems
 - 13. NFPA 810 Radio and Television Equipment
 - 14. UNDERWRITERS LABORATORIES (UL)
 - 15. UL 50 Enclosures for Electrical Equipment

16. UL 83 Thermoplastic-Insulated Wires and Cables
17. UL 94 Tests for Flammability of Plastic Materials for Parts in Devices and Appliances
18. UL 444 Standards for Communication Cables
19. UL 467 Grounding and Bonding Equipment
20. UL 486A Wire Connectors and Soldering Lugs for Use with Copper Conductors
21. UL 489 Molded-Case Circuit Breakers and Circuit-Breaker Enclosures
22. UL 508 The Standard for Industrial Control Equipment
23. UL 508A Outline of Investigation for Industrial Control Panels
24. UL 698 Industrial Control Equipment for Use in Hazardous (Classified) Locations
25. UL 886 Outlet Boxes and Fittings for Use in Hazardous Locations
26. UL 913 Intrinsically Safe Apparatus and Associated Apparatus for Use in Class I, II, and III, Division I Hazardous Locations
27. UL 1063 Machine Tool Wires and Cables
28. UL 1092 Process Control Equipment
29. UL 1203 Explosion Proof and Dust Ignition Proof Electrical Equipment for Use in Hazardous Locations
30. UL 1449 Standard for Transient Voltage Surge Suppression
31. UL 1604 Electrical Equipment for Use in Hazardous Locations, Class I and Class II, Division 2 and Class III, Divisions 1 and 2
32. UL 2225 Standard for Metal-Clad Cables and Cable Sealing Fittings for Use in Hazardous Locations
33. UL 2279 Electrical Equipment for Use in Class I, Zone 0, 1, and 2 Hazardous Locations

1.3 DEFINITION OF TERMS

- A. BOM – Bill of Materials
- B. IFB – Issued For Bid
- C. IFC – Issued For Construction
- D. FAT – Factory Acceptance Test
- E. HMI – Human Machine Interface
- F. MCC – Motor Control Center
- G. MCP (xxx) – Remote PLC Control Panels
- H. MCP 001 – SCADA PLC Control Panel
- I. MFG – Manufacturer

- J. OEM – Original Equipment Manufacturer
- K. O&M – Operations and Maintenance
- L. PLC – Programmable Logic Controller
- M. PS – Pump Station
- N. SAT – Site Acceptance Test
- O. SCADA – Supervisory Control And Data Acquisition system

1.4 SPECIAL REQUIREMENTS

- A. All Scope of Work shall be provided under the supervision of a single Contractor
- B. The Contractor shall be specialized in the design, assembly, programming, testing, installation and service of PLC and SCADA control and communication systems for at least the last (8) eight years. Contractor shall provide supporting documentation with their bid demonstrating this requirement.
- C. The Contractor shall employ technical and professional staff with documented experience in the design, assembly, programming, testing, installation, operation, troubleshooting, and service of PLC, SCADA control and communication systems. Contractor shall provide supporting documentation with their bid demonstrating this requirement.
- D. The Contractor shall be experienced with the programming and commissioning of Allen Bradley/Rockwell PLC, HMI and SCADA systems. Contractor shall provide supporting documentation with their bid demonstrating this requirement.
- E. The Contractor shall become familiar with all details of the work and verify any required dimensions and distances. Contractor shall determine network and interface wiring to/from; MCC, VFD Panels, MCP panels, field instrumentation and field Devices. If any conflicts occur necessitating departures from the drawings, details of and reasons for departures shall be submitted and approved prior to implementing any change.

1.5 STANDARD PRODUCTS

- A. Material and equipment shall be a standard product of a manufacturer regularly engaged in the manufacture of the product and shall essentially duplicate items that have been in satisfactory use for at least (4) years prior to bid opening.

1.6 MATERIALS AND EQUIPMENT

- A. The label or listing of the Underwriters Laboratories, Inc., shall be accepted as evidence that the materials or equipment conform to the applicable standards of that agency. In lieu of this label or listing, a statement from a nationally recognized, adequately equipped testing agency indicating that the items have been tested in accordance with required procedures and that the materials and equipment comply with all contract requirements will be accepted. However, materials and equipment installed in hazardous locations must bear the UL label unless the data

submitted from other testing agency is specifically approved in writing by the owner. Materials and equipment shall be approved based on the manufacturer's published data. For other than equipment and materials specified to conform to UL publications, a manufacturer's statement indicating complete compliance with the applicable Federal Specification, or standard of the American Society for Testing and Materials, National Electrical Manufacturers Association, or other commercial standard, is acceptable.

1.7 RESPONSIBILITIES

- A. The Contractor shall be fully and completely responsible for all work performed and all materials installed under the contract. All contracts between the Contractor and subcontractor(s) shall conform to and meet all requirements specified in the contract documents.
- B. The Contractor shall be responsible for but not limited to:
 - 1. Contractor shall furnish and install the new PLC and SCADA system.
 - 2. Contractor shall create Rockwell Software PLC and HMI user programs for the PLC and SCADA system as outlined.
 - 3. Contractor shall provide Submittals as outlined.
 - 4. Contractor shall coordinate and execute the FAT at their facility.
 - 5. Contractor shall coordinate and execute the SAT onsite.
 - 6. Contractor shall redline the IFC drawings with any changes made during FAT, SAT and operational testing and incorporate into As-Built set of drawings.
 - 7. Contractor shall provide recommend Spare Parts as outlined.
 - 8. Contractor to provide all electrical permits and inspections as required by the State, County, and City.
 - 9. Contractor shall provide onsite system training for the Owner. Training shall be on regular business days from 8 am to 3:00 pm.

1.8 SUBMITTALS

- A. Submit manufacturer's technical data and application instructions per Section 013323.
- B. Shop Drawings:
 - 1. Contractor shall submit manufacturers data sheets for Owner review and consideration of any material, parts or equipment substitutions/modifications prior to making a change.
- C. Submittals:
 - 1. Contractor shall prepare a complete shop drawing submittal of all (specified or substituted) components, devices, instruments and equipment, including fully detailed shop drawings, catalog cuts, wiring connections, and such other documentation as may be required to fully describe the equipment and to demonstrate its conformity to these plans and specifications. Catalog information shall be submitted for all components and equipment required for the project.
 - 2. All submittals shall be complete, organized, and indexed. Partial submittals will not be accepted. Submit (2) two hard copies and an electronic copy in pdf.

3. Owner review and approval is required on all shop drawings.
- D. Operation and Maintenance (O& M) manuals shall describe the theory of screening HMI and SCADA Screen Submittals
1. The Contractor shall provide a pdf of all completed HMI and SCADA screens required for review and approval prior to FAT execution. The screen shall represent the Contractor's final checked version and represent all the screens in the respective systems.
- E. System Drawing Submittals
1. Following approval of the shop drawing submittals, the Contractor shall provide a complete sets of panel drawings including all redline markups (where executed). All drawing redlines shall be done using a pdf editor. Hand written redlines and markups are not acceptable. Submit (2) two hard copies and an electronic copy in pdf.
- F. FAT Test Plan
1. Contractor shall submit as outlined the (2) two hard copies and an electronic copy in pdf of the FAT plan and tests that will be executed.
- G. SAT Test Plan
1. Contractor shall submit as outlined the (2) two hard copies and an electronic copy in pdf of the SAT plan and tests that will be executed.
- 1.9 OPERATION AND MAINTENANCE MANUALS
- A. Provide Operation and Maintenance (O&M) data for the SCADA PLC system. Provide (3) three copies of the system O&M manual in a three-ring binder and in pdf electronic format. The O&M manual shall include:
1. All system equipment, components and device product cutsheets with actual part number and options highlighted.
 2. control panel functions and indicator descriptions.
 3. operations and procedures.
 4. HMI color screen printouts of all screens with a function description of menus, operator control and input/output data.
 5. Troubleshooting section for control procedures
- B. Provide an O&M manual for the SCADA system workstation. The contractor shall provide (3) three copies of the SCADA O&M manual in a three-ring binder and in pdf electronic format. The O&M manual shall include:
1. All system equipment, components and device product cutsheets with actual part number and options highlighted.
 2. Color screen printouts with function descriptions, site plan, menu descriptions and procedures for interrogating data.
 3. Procedure for changing set-points, viewing alarms, trend and event logs and printing screens, logs, trends and data.

4. The operation shall include a trouble shooting section with procedures for restarting the PC, SCADA software, and operating system.

1.10 SPARE PARTS

- A. Spare parts shall be furnished as specified below. All spare parts shall be the same make, model, # and options as the respective approved part in the submittals. Spare parts shall be furnished new in OEM packaging.
 1. PLC CPU (Qty. 1)
 2. PLC Relay Output Card (Qty. 1 for each type used)
 3. PLC Input Card (Qty. 1 for each type used)
 4. PLC Analog Input Card (Qty. 2 for each type used)
 5. PLC Analog Output Card (Qty. 1 each type used)
 6. PLC Power Supplies (Qty. 1 of each type used)
 7. Control Panel UPS (Qty. 1)
 8. 24 Vdc Power Supply (Qty. 1)
 9. 24 Vdc Redundant Power Supply Module (Qty. 1).

PART 2 - PRODUCTS

2.1 GENERAL

- A. Material shall be new, free from defects, and of the quality specified. All equipment and materials utilized in the system shall be the products of manufacturers with a minimum of (8) eight years of experience in the manufacture of similar equipment. Similar items in the system shall be the products of the same manufacturer. All equipment shall be of industrial grade and shall be specifically intended for control, monitoring and operation of motor-driven pumps and equipment. All equipment shall be of modular design to facilitate interchangeability of parts and to assure ease of servicing.

2.2 MAJOR EQUIPMENT LIST

- A. Provide all equipment and devices shown on the drawings and specified herein, including but not limited to, the following major Control System equipment:
 1. PLC System with HMI
 2. Rockwell ControlLogix 5000 and Rockwell FactoryTalk HMI Software Licenses
 3. SCADA system hardware and software as outlined.

2.3 PLC CONTROL PANEL

- A. Similar items in the system shall be products from the same Manufacturer.

- B. Material shall be new, free from defects, and of the quality specified. All equipment shall be of industrial grade and of standard construction, shall be capable of long, reliable, trouble-free service, and shall be specifically intended for control and monitoring industrial equipment.
1. Control Panel Identification Nameplates
 - a. Nameplates shall be furnished for all door mounted devices. Nameplates shall be duralith or micarta with black letters on white background. Letters shall be 3/16" high with seven (7) letters per inch, except where indicated otherwise. Engraving shall be done with a blunt tool to provide clear wide lines. Refer to design drawings for control panel front door nameplate schedule.
 - b. All components mounted on interior removable panel shall have identification adjacent to each device, using same material as paragraph above except black letters on yellow background. The nameplate shall identify the device and schematic device number. The nameplates shall be located to provide an unobstructed view of nameplate after wiring is complete. All identification nameplates shall have chamfered edges and fastened with stainless steel round head sheet metal screws.
 2. NEMA 4 Control Enclosure and Back-Panel
 - a. NEMA 4 painted steel enclosure with lockable front door. Where enclosure is floor mounted, provide the corresponding painted steel stand kit intended from the enclosure manufacturer.
 - b. A removable white painted steel back panel shall be provided for the mounting of components. Panel shall be from the enclosure manufacturer and intended for enclosure size.
 - c. Saginaw or Hoffman
 3. Control Wiring
 - a. Wire shall be color coded as follows:
 - 1) AC Line & Load: Black
 - 2) AC Control: Red
 - 3) Neutral: White
 - 4) DC + Power: Blue
 - 5) DC Control: Blue
 - 6) DC - Common: White/blue stripe
 - 7) Mechanical Ground: Green or Green/Yellow Stripe
 - 8) Control Wiring Powered from Other Sources: Yellow
 - b. Conductor size shall be stranded #14 or larger (as required). All control, interface and power wire terminating in the panel shall be stranded wire type THHN, heavy wall except where otherwise specified. DC control wiring shall be stranded #16 AWG or larger (as required) except where otherwise specified.
 - c. All shielded cable shall be stranded #18 AWG with a 100% coverage shield and drain wire, 150-volt insulation except where otherwise specified. All wiring shall be copper conductors.
 4. Terminal Blocks
 - a. Terminal blocks shall be sized to accept wires terminating there on with a minimum of 250VAC rating at 15 amps. Terminal blocks shall be suitable for high rise DIN rail mounting. The blocks shall have a tin-plated copper alloy terminals and a marking surface for circuit identification.
 - b. Multilevel blocks shall be used for analog I/O shield terminations.
 - c. Multilevel common connection terminal blocks shall be used for DC circuit distribution.
 - d. All terminal blocks shall be from the same manufacturer.

5. Wiring Duct and Cover
 - a. The wiring duct and cover shall be constructed of white rigid vinyl (PVC). The wiring duct shall have angled and interlocking lips to permit the duct cover to interlock with the duct. Wiring duct and covers shall be from the same manufacturer.
6. Control Panel Enclosure Heater
 - a. The heater shall be designed for use in a control panel enclosure. The heater shall operate at 120VAC and sized (where required) to provide required heat for environment and component cold temperature specifications. The heater shall have an integral thermostat to automatically control the heater operation. The thermostat shall have minimum adjustment of 40 degrees F to 80 degrees F. The heater shall contain a ball bearing type fan that runs continuously. The heater shall be a self-contained metal housed unit.
7. Control Panel Thermostats – For Panel Temperature Alarm DI
 - a. The control panel thermostat shall be a self-contained unit designed for use in control panel enclosures and DIN rail mounting. It shall have a minimum of one normally open contact rated for 120VAC at 1A inductive load. It shall have a minimum set-point adjustment from 40 degrees F to 90 degrees F. The thermostat shall have screw type connections
8. Control Relays
 - a. The control relay coil voltages shall be as indicated on the drawings. The relays shall be socket type terminals with a mating socket base. The socket base shall be suitable for DIN rail mounting and have pressure plate screw terminal connections. The relays shall have a minimum of two Form C contacts, rated for a minimum of 8 amps each at 120 VAC. The contacts shall be gold. The relay shall have an ON/OFF indicator. All control relays shall be from the same manufacturer.
9. Timer Relays - On Delay (Where Required)
 - a. The timer relay coil voltages shall be as indicated on the design drawings. The relays shall be socket type with a mating socket base. The socket base shall be suitable for DIN rail mounting and have pressure plate screw terminal connections. The relays shall have a minimum of two Form C contacts, rated for a minimum of 3 amps each at 120 VAC. The contacts shall be silver. The timing adjustment shall have a maximum on delay time of 200 seconds and a minimum on delay time of 1 second.
10. Control Panel Receptacle
 - a. The control panel receptacle shall be a 120VAC 15 AMP receptacle mounted inside the control panel enclosure and designed for panel mounting.
11. 120 VAC Single Pole Circuit Breakers
 - a. The single pole breakers shall be a thermal magnetic type rated for 10KA short circuit interrupt current at 120 Vac. The unit shall be rated for a minimum of 230VAC operating voltage and have a minimum electromechanical life of at least 20,000 cycles. The circuit breaker shall have finger and hand touch safe screw type connections and designed for DIN rail mounting. Trip curve as outlined in BOM. Single pole circuit breakers shall be from the same manufacturer.
12. 24 VDC Single Pole Circuit Breakers
 - a. The single pole breakers shall be a thermal magnetic type rated for 10KA short circuit interrupt current at 250 Vdc. The unit shall be rated for 125 Vdc and have a minimum electromechanical life of at least 20,000 cycles. The circuit breaker shall have finger and hand touch safe screw type connections and designed for DIN rail mounting. Single pole circuit breakers shall be from the same manufacturer.

13. Network Switch
 - a. The Ethernet switch shall have required number of ports plus quantity 4 spare RJ45 ports. RJ45 ports support a transmission speed of 10/100 Mbps with autodetect and negotiation. ST type TX/RX fiber ports as required to connect to other PLC and VFD panels. Unit is designed for direct DIN rail mount. The Ethernet switch power will be 24VDC. Rated for installation with adjacent components on the DIN rail without derating. MTBF greater than 80 years/700,000 hours at 25 °C operating. Minimum operating temperature range -10 °C to 60 °C.
14. 24 Vdc Redundant Power Supplies
 - a. The 24 Vdc power supplies shall be 120 Vac powered and provide 24 Vdc and sized with 75% additional output current above the connected 24 VDC load. The 24 Vdc output shall be adjustable from 24 to 28 Vdc. Maximum DC ripple of 50 mV peak to peak. Designed for direct DIN Rail mount. Rated at full current output up to an enclosure temperature of 40 °C. Designed to be installed with no air gap between adjacent power supplies and redundancy modules with a maximum of 40mm required space above and 20 mm required below the unit. Each individual power supply shall have dry contact output for power supply OK status. MTBF greater than 80 years/700,000 hours at 25 °C operating. Minimum operating temperature range -10 °C to 60 °C.
 - b. The redundancy module shall be of the same manufacturer as the 24 Vdc power supplies and designed to handle the current of the power supplies. The module shall use MOSFETs for reduced heat and voltage drop across the module. MTBF greater than 80 years/700,000 hours at 25 °C operating. Minimum operating temperature range -10 °C to 60 °C.
15. Uninterruptible Power Supply
 - a. The uninterruptible power supply shall be rated for 120VAC with a 1000VA capacity. The unit shall be a self-contained unit with a 6 foot, NEMA 5-15P male plug and a minimum of 4 battery/surge receptacles. The unit shall have an input voltage window from 80VAC to 150VAC for utility operation. The unit shall compensate for utility under-voltage (90VAC to 105VAC) by boosting the output. The unit shall compensate for utility over-voltage (125VAC to 140VAC) by decreasing the output. When running on battery the unit shall provide 115VAC output with a maximum +/- 8% allowable deviation at 60Hz with a maximum +/- 0.1 Hz deviation. The transfer time shall be a maximum of 4 ms. The unit shall have an online circuit breaker and internal battery internal current limiting. The batteries shall be a hot swappable, sealed, maintenance free lead acid type. The maximum recharge time shall be 5 hours from a completely discharged state. The unit shall have indicator lights for "online", "on battery", "ups overloaded" and "replace battery". There shall be an audible alarm for "on battery", "low battery" and "overload". The UPS shall have one alarm contact rated for a minimum of 1 amp at 120VAC. The alarm contact shall close when the UPS has an overload or faulty battery. The unit shall have full time EMI and RFI filtering and surge protection.
 - b. The unit dimensions shall be such that it is located on the bottom of the PLC panel enclosure and is easily removable by 120VAC cords and panel interior receptacle. No wiring required to swap or bypass.
16. Control Panel Surge Suppressor
 - a. The surge suppressor shall be rated for an operating voltage of 120VAC at 30 amps and tested to meet the ANSI/IEEE C62.41 1991 and ANSI.IEEE C62.45 1987. It shall have a clamping voltage of 350 Volts or better on a category A3-200A ring wave test on line to neutral and line to ground. It shall have a clamping voltage of 500 volts or

better on a category C1-3000 amp impulse wave test on line to ground and neutral to ground. It shall have a minimum of 40db of EMI/RFI attenuation. The suppression unit shall not require scheduled maintenance or fuse replacement.

17. Intrinsically Safe (IS) Barrier
 - a. Provide IS barriers for all devices and instruments terminating in the panel that are field located in classified areas. IS barrier shall be rated for field device type and signals. Provide cover over IS barrier on field wiring side.
18. Control Panel Pushbuttons
 - a. The pushbuttons shall have a minimum of two normally open and two normally closed contacts rated for 7 amps at 120VAC. The contacts shall be field removable for future replacement. The unit shall be rated for a minimum of 1 million cycles. The pushbutton shall be a flush operator. The pushbuttons shall be rated for NEMA 4/4X. The pushbutton shall have a minimum diameter of 30mm, NEMA style.
 - b. Provide front door mounted pushbuttons as required for operator manual control or resetting. Operator shall not be required to open the panel to clear alarms or control/start/stop devices.
19. Control Panel Pilot Lights
 - a. The pilot lights shall be dual input LED cluster lamps. They shall have inline resistors and diodes to protect the LED lamp on both inputs to the lamp. The pilot light shall be rated for NEMA 4/4X. The pilot light shall have a minimum diameter of 30mm, NEMA style. The LED cluster and lens shall be of the same color. The led cluster and lens shall be field removable for future replacement. The color of the pilot light shall be as indicated on the panel layout drawings.
 - b. Pilot lights, pushbuttons, and selector switches shall be from the same manufacturer.
 - c. Provide front door mounted green run and red fault pilot lights for all motor starters and VFDs controlled by the respective MCP panel.
20. HOA Selector Switches
 - a. The selector switches shall have a minimum of two normally open and two normally closed contacts rated for 7 amps at 120VAC. The contacts shall be field removable for future replacement. The unit shall be rated for a minimum of 1 million cycles. The unit shall be a three-position maintained operator. The units shall be rated for NEMA 4/4X and have a minimum diameter of 30mm, NEMA style.
 - b. Pilot lights, pushbuttons, and selector switches shall be from the same manufacturer.
 - c. Provide front door mounted green run and red fault pilot lights for all motor starters and VFDs controlled by the respective MCP panel.

2.4 PLC SYSTEM

A. PLC Hardware

1. All PLC hardware shall be Allen Bradley CompactLogix 5069 Family with 5380-LXXX processor - no exceptions.
2. Provide required PLC digital and analog I/O cards with 25% spare by card type.
3. Provide either Ethernet RJ45 port on the CompactLogix processor or via an Ethernet card in the chassis
4. All PLC digital inputs shall be 24 VDC

5. All digital outputs shall be CompactLogix Relay output cards. Relay outputs shall be wired to a respective DIN rail mounted control relay where controlling an isolated, separate power or AC circuit.
6. All PLC digital/analog inputs and outputs shall be terminated. This includes all unused inputs and outputs. All input and output devices connected to the PLC shall be terminated on the respective TB group for that card. Wiring to spare inputs and outputs shall bear the I/O number as the wire number.
7. Direct wiring of panel components and field devices on the PLC cards is not permitted.

B. HMI

1. HMI screen shall be NEMA 4 rated for front door mounting
2. Operating temperature 0 °C to +50 °C
3. 15" color touch screen
4. 10/100 Base Ethernet, 24 VDC, 80MB user memory
5. Built in driver for Allen Bradley CompactLogix communications
6. Provide all required cables and pre-loaded development software and licenses for a complete and operational system.
7. Contractor shall program, test and commission the HMI.
8. PanelView Plus 7, Beijer, Red Lion or approved equivalent

C. Programming of PLC and HMI

1. The Contractor shall provide all programming, functional testing and commissioning for the entire control system according to functional specifications and vendor specifications for a complete operating system.
2. The programmer shall provide all required programming for a complete and functional control system.
3. Adjustments or additional sequence interlocks, alarming, or minor graphic features added during FAT, commissioning and or SAT shall be included in the bid price.
4. The Contractor shall provide all field technicians to execute the startup and functional checkouts and performance testing of the complete PLC and SCADA.

D. PLC & HMI Programming Software

1. Rockwell Studio 5000 Version 9.01 and HMI programming software are provided by the Contractor for Contractor use in developing the software applications for the project.

2.5 SCADA COMPUTER SYSTEM AND EQUIPMENT

A. A complete SCADA computer system shall be provided by the Contractor. Dell or equal with the following minimum requirements:

1. Intel Core i9, 16M Cache, 8 core, 5.2 GHz or latest premium processor
2. GeForce, 12 GB GDDR6 or equal. No onboard video card.
3. (2) 8 GB DDR5 SDRAM 4800 MHz, 2 SODIMMs

4. 2 TB M.2 NVMe SSD, M.2 PCIe Interface
5. Energy efficient power supply
6. 10/100/1000/2500Mb Base-TX Ethernet and Fiber Network Card, Wired and Wireless
7. USB Ports
8. Qty (2) 32" UHD flat panel display DVI
9. 1 TB flash drive to backup all SCADA, PLC and HMI files post commissioning
10. Wireless optical mouse and Wireless keyboard
11. 1000VA UPS w/surge protection and power strip
12. 1 year hardware warranty

B. SCADA Software and Licensing Drive Unit

1. Windows 10 Professional operating system, 64 bit licensed to Sunbury
2. Windows Office Professional, latest edition licensed to Sunbury
3. Rockwell FactoryTalk SE Runtime Unlimited Version 11.0 including ViewPoint and licensed to Sunbury and installed by Contractor on the new SCADA PC.
4. Rockwell FactoryTalk Development SCADA development software is provided by the Contractor for their use in developing, adjusting, and commissioning the SCADA software applications for the project on the new SCADA system.
5. WIN-911Alarm/Event messaging software. Latest version for use with FactoryTalk SE.

PART 3 - EXECUTION

3.1 GENERAL

- A. Install materials and equipment in a workman-like manner utilizing craftsmen skilled in the respective trade. Provide work which has a neat and finished appearance.
- B. Conduit penetrations are not permitted through the top of any enclosures or equipment..

3.2 MCP GENERAL

A. Grounding

1. The control panel enclosure, back panel and front door shall be grounded to the incoming ground bus using #14 green stranded wire. All internal and field ground wiring shall be grounded to the ground terminals. The ground terminals shall be grounded to the incoming ground bus using #14 green stranded wire.

B. Enclosure Cutouts

1. All new cutouts on the enclosures and doors shall be made with a hydraulic die-type knockout tool. Knockout size for mounting components shall be in accordance with the component manufacturers installation specifications. Knockouts for pushbuttons, pilot lights and selector switches shall be 2.75 inch centers.
2. Top penetrations of the panel enclosures are not permitted.

3. All cutouts shall be free from burrs, rough edges and damage. Incorrect cutouts compromising the respective NEMA ratings of the enclosure or impairing proper solid mounting of the respective component will require the Contractor to replace the door or enclosure. Repairs and are not acceptable.

C. Wiring Identification

1. All control wires shall be identified at both ends with numbers shown on the design drawings using heat shrinkable identification sleeves, computer generated black lettering on white sleeve. Handwritten wire numbering will not be accepted.

D. Nameplate Identification

1. All devices and equipment mounted on the removable back-panel shall have identification adjacent to each device. All nameplates shall be located to provide an unobstructed view of nameplate after wiring is complete. Do not mount nameplates on wireway covers.

E. Internal Panel Wire Routing

1. A.C. and D.C. wiring shall be kept separate as much as possible. All A.C. and D.C. control wire shall be terminated in terminal blocks. All shielded wire conductors shall be furnished before terminating with a slip-on crimp style pin terminal with an insulated grip. If a method of distributing strain on wire bent frequently such as those connected to devices on doors is not employed, extra flexible hinge wire shall be used.

3.3 PLC PROGRAMMING

A. The Contractor shall create the station CompactLogix PLC program based on the functional specifications and vendor functional specifications. The CompactLogix PLC program shall also provide as a minimum all the following features:

1. Logic, data and descriptions not relevant or used for the respective station shall be removed from each program prior to FAT and/or SAT.
2. Motor start/stop, sequence, interlocks, setpoints
3. Auto and Manual control
4. All Alarm and Events and qualification
5. Alarm interface with HMI and SCADA
6. Setpoint and Control interface from HMI and SCADA
7. The program shall be written in a fault tolerant manner to prevent frequent operator intervention. The program shall not require operator intervention on a PLC restart.
8. PLC shall monitor the Emergency Stop status and turn off all required motors via output cards or run/speed commands over Ethernet. Emergency Stop recovery program sequence shall be coordinated with Owner/Engineer for specific equipment requiring operator restart or a PLC automatic restart.
9. The program structure shall be divided into subroutines for each logical process and equipment group. Communication routines and data shall be in respective separate subroutines.
10. Communication interface and HMI/SCADA shall all be in respective separate subroutines.

11. All analog data values shall be scaled in the program. The scaled value shall represent the real final value. Scaling in the HMI and SCADA is not permitted.
12. Programs shall be written in ladder format. Programs shall be fully documented with rung and address comments. Comments at the start of new logic routines. Provide I/O listings, address, data usage and configuration printouts. All data table words shall have descriptions.

3.4 HMI & SCADA PROGRAMMING

- A. Screen graphics, details and layout shall take advantage of the screen size, resolution for a high level of detail on equipment and devices. Screens and functions shall be intuitive, text size easy to read. Navigation within and between screens shall be intuitive. Main overall station screen graphic shall be the default home screen. Dark screen saver shall be used for periods of inactivity greater than 30 minutes.
- B. The Contractor shall accurately depict equipment and devices for the respective station. Box or circle outlines representing equipment and devices or P&ID symbols will not be accepted. The contractor shall provide moving and/or color animation for all moving or rotating pieces of equipment, devices, and fluid flow including but not limited to: motors, pumps, fluids with flow status in pipes.
- C. Animation Color
 1. Screen animation color shall be as follows unless otherwise indicated:
 2. Instrumentation feedback in Alarm – Flashing Red
 3. Fault, Overload, or Alarm – Flashing Red
 4. Equipment or Device Running – Solid Green
 5. Equipment or Device Stopped – Solid Red
 6. Start Button – Solid Green
 7. Stop Button – Solid Red
 8. Valve Open - Solid Green
 9. Valve Closed – Solid Red
- D. Motor and Pump Control
 1. Provide control and status of AUTO/MANUAL modes and Manual Start/Stop. For VFD controlled equipment. Provide a Manual Mode speed setpoint in 0 to 60 Hz. Screen animation color shall be as outlined.
 2. Provide 24 hour and weekly motor run time totalizers for all motors. The 24 hour totalizers shall have a common administrator adjustable 24 hour totalizer reset time. All totalizers shall be trended and the ability to be exported as outlined in Data Storage and Exports
- E. Common Screen Features
 1. Time and date
 2. Screen name
 3. Login/out button

4. Display the user name currently logged in
5. Station name
6. Navigation tree

F. Trend Screens

1. All PLC analog input values shall be viewable in real-time and historical with a trend display, plotting sampled data (Y-axis) vs. time (X-axis) in graphical format. Include navigation for time scrolling through the trend chart and entry box for selecting date and time. Include moveable scroll line that displays value.
2. Provide the ability to group PLC analog inputs in a common trend for analysis

G. Alarming

1. Provide an alarm summary screen that displays the alarms in order as they occurred and the acknowledged or unacknowledged status. The alarm descriptions shall be concise so that the operator can understand the exact nature of the alarm condition. The time and date the alarm occurred shall be displayed for each alarm. Provide alarm acknowledging and alarm clearing features. Acknowledged points that are not in alarm shall automatically clear from the Alarm Summary.
2. Alarm Screen status color is as follows:
 - a. Red and flashing – unacknowledged and in alarm
 - b. Red and not flashing – acknowledged and in alarm
 - c. Blue – unacknowledged, was in alarm but cleared

H. WIN-911

1. Configure the WIN-911 software and coordinate with Owner on call/email/text lists, message content and respective alarms/events connected to the lists.

I. Security

1. Screens shall be setup with Admin access for setpoint changes and a View user access for viewing only and acknowledging alarms.
2. FactoryTalk Viewpoint will be password protected with Administrator User Account Control. The FactoryTalk client will be set to read only as to not allow process control changes through the web client.

3.5 FACTORY ACCEPTANCE TESTING

A. General:

The contractor shall assemble and integrate the FAT at their facility to prove that the performance of the system satisfies all requirements of this project. The FAT shall take place during regular daytime working hours on weekdays within a minimum of 1 month prior to the project online date. Model numbers and software revisions shall be identical to those to be delivered to site. Original copies of data produced during the FAT, including results of each demonstration procedure, shall be delivered to the owner and or engineer at the conclusion of the test. The report shall be arranged so that commands, responses, and data acquired are correlated to allow logical interpretation of the data.

1. SCADA system hardware and software and custom software as specified.

2. SCADA workstations operation demonstration.
3. PLCs, HMIs, are communicating on the designated network(s)
4. PLCs are fully programmed and operational as specified
5. Actual or simulated field devices/equipment are configured to facilitate the testing.

B. Create and submit an FAT test document for approval prior to scheduling and executing the FAT. The FAT test document shall be a spreadsheet including but PLC & HMI CONTROL PANEL not limited to the following columns; Action/Function Description, Expected Result, Actual Result, Pass Fail, Comments. The FAT test shall verify all the functional requirements including operator setpoint changes, operator mode changes and demonstration of the sequence of operations by logical equipment grouping or program process. Alarming shall be tested including; display, enable/disable, acknowledgement, and history log. The alarm testing shall be executed for each unique equipment or process alarm. For example; 2. demonstrate a "Motor Failed to Start" alarm for 1 motor. The following is required prior to scheduling or executing the FAT test.

1. Approved HMI screens and software
2. Approved SCADA screens and software
3. Approved PLC and hardware

3.6 SITE ACCEPTENCE TEST EXECUTION

A. General

The SAT shall take place during regular daytime working hours on weekdays within a minimum of 2 weeks prior to the project online date. Original copies of data produced during the SAT, including results of each demonstration procedure, shall be delivered to the owner and or engineer at the conclusion of the SAT. The report shall be arranged so that commands, responses, and data acquired are correlated to allow logical interpretation of the data.

B. Test Failure Assessment

1. If the test was stopped due to failures the Contractor shall identify the failures, determine causes of failures, repair failures, and deliver a written report to Owner. The report shall explain in detail the nature of each failure, corrective action taken, results of tests performed, and shall recommend the point at which the testing should be resumed. After delivering the written report, the Contractor shall convene a test review meeting at the job site to present the results and recommendations to the Owner. The meeting shall not be scheduled earlier than 5 business days after receipt of the report by the contracting officer. As a part of this test review meeting, the contractor shall demonstrate that the failure have been corrected. Based on the contractor's report and the test review meeting, Owner will determine the restart point, and may require the endurance test be totally or partially rerun. The Contractor shall not commence any required re-testing until after receipt of written notification by Owner.
2. The contractor will not be held responsible for failures resulting from the following: An outage of the main power supply in excess of the capability of any backup power source, provided that the automatic initiation of all backup sources was accomplished. Failure of existing equipment and existing instrumentation, provided that the failure was not due to contractor furnished equipment, installation, or software.

END OF SECTION 409600

SECTION 409601 – CONTROL PANEL FOR EXTERIOR LOCATIONS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, and Division-1 Specification sections apply to work of this section.
- B. This Section includes the general requirements for furnishing, installing, programming, adjusting, testing, documenting and commissioning of the complete and operational PLC based control system that is part of the Sunbury WWTP control system.
- C. Related Sections:
 - 1. Section 260010 – General Requirements
 - 2. Section 260020 - Demolition
 - 3. Section 260519 – Conductors
 - 4. Section 260526 – Grounding
 - 5. Section 409600 – PLC & SCADA Control System
 - 6. Section 409602 – Control Panel for Interior Locations

1.2 REFERENCE

- A. The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.
 - 1. IEEE C62.41 Surge Voltages in Low-Voltage AC Power Circuits
 - 2. National Electrical Manufacturers Association (NEMA)
 - 3. NEMA 250 Enclosures for Electrical Equipment (1000 Volts Maximum)
 - 4. NEMA AB 1 Molded Case Circuit Breakers and Molded Case Switches
 - 5. NEMA ICS 1 Industrial Controls and Systems
 - 6. NEMA ICS 2 Industrial Control Devices, Controllers and Assemblies
 - 7. NEMA ICS 4 Industrial Control and Systems: Terminal Blocks
 - 8. NEMA ICS 6 Enclosures for Industrial Control and Systems
 - 9. NEMA ST1 Standard for specialty transformers
 - 10. National Fire Protection Association (NFPA)
 - 11. NFPA 70 National Electrical Code
 - 12. NFPA 780 Installation of Lightning Protection Systems
 - 13. NFPA 810 Radio and Television Equipment
 - 14. UNDERWRITERS LABORATORIES (UL)
 - 15. UL 50 Enclosures for Electrical Equipment

16. UL 83 Thermoplastic-Insulated Wires and Cables
17. UL 94 Tests for Flammability of Plastic Materials for Parts in Devices and Appliances
18. UL 444 Standards for Communication Cables
19. UL 467 Grounding and Bonding Equipment
20. UL 486A Wire Connectors and Soldering Lugs for Use with Copper Conductors
21. UL 489 Molded-Case Circuit Breakers and Circuit-Breaker Enclosures
22. UL 508 The Standard for Industrial Control Equipment
23. UL 508A Outline of Investigation for Industrial Control Panels
24. UL 698 Industrial Control Equipment for Use in Hazardous (Classified) Locations
25. UL 886 Outlet Boxes and Fittings for Use in Hazardous Locations
26. UL 913 Intrinsically Safe Apparatus and Associated Apparatus for Use in Class I, II, and III, Division I Hazardous Locations
27. UL 1063 Machine Tool Wires and Cables
28. UL 1092 Process Control Equipment
29. UL 1203 Explosion Proof and Dust Ignition Proof Electrical Equipment for Use in Hazardous Locations
30. UL 1449 Standard for Transient Voltage Surge Suppression
31. UL 1604 Electrical Equipment for Use in Hazardous Locations, Class I and Class II, Division 2 and Class III, Divisions 1 and 2
32. UL 2225 Standard for Metal-Clad Cables and Cable Sealing Fittings for Use in Hazardous Locations
33. UL 2279 Electrical Equipment for Use in Class I, Zone 0, 1, and 2 Hazardous Locations

1.3 DEFINITION OF TERMS

- A. BOM – Bill of Materials
- B. IFB – Issued for Bid
- C. IFC – Issued for Construction
- D. FAT – Factory Acceptance Test
- E. HMI – Human Machine Interface
- F. MCC – Motor Control Center
- G. MCP (xxx) – Remote PLC Control Panels
- H. MCP 001 – SCADA PLC Control Panel
- I. MFG – Manufacturer

- J. OEM – Original Equipment Manufacturer
- K. O&M – Operations and Maintenance
- L. PLC – Programmable Logic Controller
- M. PS – Pump Station
- N. SAT – Site Acceptance Test
- O. SCADA – Supervisory Control and Data Acquisition system

1.4 SPECIAL REQUIREMENTS

- A. All Scope of Work shall be provided under the supervision of a single Contractor.
- B. The Contractor shall be specialized in the design, assembly, programming, testing, installation and service of PLC and SCADA control and communication systems for at least the last (8) eight years. Contractor shall provide supporting documentation with their bid demonstrating this requirement.
- C. The Contractor shall employ technical and professional staff with documented experience in the design, assembly, programming, testing, installation, operation, troubleshooting, and service of PLC, control and communication systems. Contractor shall provide supporting documentation with their bid demonstrating this requirement.
- D. The Contractor shall be experienced with the programming and commissioning of Allen Bradley/Rockwell PLC, and HMI. Contractor shall provide supporting documentation with their bid demonstrating this requirement.
- E. The Contractor shall become familiar with all details of the work and verify any required dimensions and distances. Contractor shall determine network and interface wiring to/from; MCC, VFD Panels, vendor equipment and SCADA System, field instrumentation and field Devices. If any conflicts occur necessitating departures from the drawings, details of and reasons for departures shall be submitted and approved prior to implementing any change.

1.5 STANDARD PRODUCTS

- A. Material and equipment shall be a standard product of a manufacturer regularly engaged in the manufacture of the product and shall essentially duplicate items that have been in satisfactory use for at least (4) years prior to bid opening.

1.6 MATERIALS AND EQUIPMENT

- A. The label or listing of the Underwriters Laboratories, Inc., shall be accepted as evidence that the materials or equipment conform to the applicable standards of that agency. In lieu of this label or listing, a statement from a nationally recognized, adequately equipped testing agency indicating that the items have been tested in accordance with required procedures and that the materials and equipment comply with all contract requirements will be accepted. However, materials and equipment installed in hazardous locations must bear the UL label unless the data

submitted from other testing agency is specifically approved in writing by the owner. Materials and equipment shall be approved based on the manufacturer's published data. For other than equipment and materials specified to conform to UL publications, a manufacturer's statement indicating complete compliance with the applicable Federal Specification, or standard of the American Society for Testing and Materials, National Electrical Manufacturers Association, or other commercial standard, is acceptable.

1.7 RESPONSIBILITIES

- A. The Contractor shall be fully and completely responsible for all work performed and all materials installed under the contract. All contracts between the Contractor and subcontractor(s) shall conform to and meet all requirements specified in the contract documents.
- B. The Contractor shall be responsible for but not limited to:
 - 1. Contractor shall furnish and install the new PLC control system.
 - 2. Contractor shall create Rockwell Software PLC and HMI user programs for the PLC system as outlined.
 - 3. Contractor shall provide Submittals as outlined.
 - 4. Contractor shall coordinate and execute the FAT at their facility.
 - 5. Contractor shall coordinate and execute the SAT onsite.
 - 6. Contractor shall redline the IFC drawings with any changes made during FAT, SAT and operational testing and incorporate into As-Built set of drawings.
 - 7. Contractor shall provide recommend Spare Parts as outlined.
 - 8. Contractor to provide all electrical permits and inspections as required by the State, County, and City.
 - 9. Contractor shall provide onsite system training for the Owner. Training shall be on regular business days from 8 am to 3:00 pm.

1.8 SUBMITTALS

- A. Submit manufacturer's technical data and application instructions per Section 013323.
- B. Shop Drawings:
 - 1. Contractor shall submit manufacturers data sheets for Owner review and consideration of any material, parts or equipment substitutions/modifications prior to making a change.
- C. Submittals:
 - 1. Contractor shall prepare a complete shop drawing submittal of all (specified or substituted) components, devices, instruments and equipment, including fully detailed shop drawings, catalog cuts, wiring connections, and such other documentation as may be required to fully describe the equipment and to demonstrate its conformity to these plans and specifications. Catalog information shall be submitted for all components and equipment required for the project.
 - 2. All submittals shall be complete, organized, and indexed. Partial submittals will not be accepted. Submit (2) two hard copies and an electronic copy in pdf.

3. Owner review and approval is required on all shop drawings.

D. HMI Screen Submittals

1. The Contractor shall provide a pdf of all completed HMI screens required for review and approval prior to FAT execution. The screen shall represent the Contractor's final checked version and represent all the screens in the respective systems.

E. System Drawing Submittals

1. Following approval of the shop drawing submittals, the Contractor shall provide a complete sets of panel drawings including all redline markups (where executed). All drawing redlines shall be done using a pdf editor. Handwritten redlines and markups are not acceptable. Submit (2) two hard copies and an electronic copy in pdf.

F. FAT Test Plan

1. Contractor shall submit as outlined the (2) two hard copies and an electronic copy in pdf of the FAT plan and tests that will be executed.

G. SAT Test Plan

1. Contractor shall submit as outlined the (2) two hard copies and an electronic copy in pdf of the SAT plan and tests that will be executed.

1.9 OPERATION AND MAINTENANCE MANUALS

A. Provide Operation and Maintenance (O&M) data for the SCADA PLC system. Provide (3) three copies of the system O&M manual in a three-ring binder and in pdf electronic format. The O&M manual shall include:

1. All system equipment, components and device product cutsheets with actual part number and options highlighted.
2. control panel functions and indicator descriptions.
3. operations and procedures.
4. HMI color screen printouts of all screens with a function description of menus, operator control and input/output data.
5. Troubleshooting section for control procedures

1.10 SPARE PARTS

A. Spare parts shall be furnished as specified below. All spare parts shall be the same make, model, # and options as the respective approved part in the submittals. Spare parts shall be furnished new in OEM packaging.

1. PLC CPU (Qty. 1)
2. PLC Relay Output Card (Qty. 1 for each type used)
3. PLC Input Card (Qty. 1 for each type used)
4. PLC Analog Input Card (Qty. 2 for each type used)
5. PLC Analog Output Card (Qty. 1 each type used)

6. PLC Power Supplies (Qty. 1 of each type used)
7. Control Panel UPS (Qty. 1)
8. 24 Vdc Power Supply (Qty. 1)
9. 24 Vdc Redundant Power Supply Module (Qty. 1).

PART 2 - PRODUCTS

2.1 GENERAL

- A. Material shall be new, free from defects, and of the quality specified. All equipment and materials utilized in the system shall be the products of manufacturers with a minimum of (8) eight years of experience in the manufacture of similar equipment. Similar items in the system shall be the products of the same manufacturer. All equipment shall be of industrial grade and shall be specifically intended for control, monitoring and operation of motor-driven pumps and equipment. All equipment shall be of modular design to facilitate interchangeability of parts and to assure ease of servicing.

2.2 MAJOR EQUIPMENT LIST

- A. Provide all equipment and devices shown on the drawings and specified herein, including but not limited to, the following major Control System equipment:
 1. PLC System with HMI
 2. Rockwell ControlLogix 5000 and Rockwell FactoryTalk HMI Software Licenses.

2.3 PLC CONTROL PANEL

- A. Similar items in the system shall be products from the same Manufacturer.
- B. Material shall be new, free from defects, and of the quality specified. All equipment shall be of industrial grade and of standard construction, shall be capable of long, reliable, trouble-free service, and shall be specifically intended for control and monitoring industrial equipment.
 1. Control Panel Identification Nameplates
 - a. Nameplates shall be furnished for all door mounted devices. Nameplates shall be duralith or micarta with black letters on white background. Letters shall be 3/16" high with seven (7) letters per inch, except where indicated otherwise. Engraving shall be done with a blunt tool to provide clear wide lines. Refer to design drawings for control panel front door nameplate schedule.
 - b. All components mounted on interior removable panel shall have identification adjacent to each device, using same material as paragraph above except black letters on yellow background. The nameplate shall identify the device and schematic device number. The nameplates shall be located to provide an unobstructed view of nameplate after wiring is complete. All identification nameplates shall have chamfered edges and fastened with stainless steel round head sheet metal screws.
 2. Control Enclosure and Back-Panel

- a. NEMA 4X stainless steel enclosure with lockable front door. Where enclosure is floor mounted, provide the stainless steel stand kit intended from the enclosure manufacturer.
 - b. A removable white painted steel back panel shall be provided for the mounting of components. Panel shall be from the enclosure manufacturer and intended for enclosure size.
 - c. Saginaw or Hoffman
3. Control Wiring
- a. Wire shall be color coded as follows:
 - 1) AC Line & Load: Black
 - 2) AC Control: Red
 - 3) Neutral: White
 - 4) DC + Power: Blue
 - 5) DC Control: Blue
 - 6) DC - Common: White/blue stripe
 - 7) Mechanical Ground: Green or Green/Yellow Stripe
 - 8) Control Wiring Powered from Other Sources: Yellow
 - b. Conductor size shall be stranded #14 or larger (as required). All control, interface and power wire terminating in the panel shall be stranded wire type THHN, heavy wall except where otherwise specified. DC control wiring shall be stranded #16 AWG or larger (as required) except where otherwise specified.
 - c. All shielded cable shall be stranded #18 AWG with a 100% coverage shield and drain wire, 150-volt insulation except where otherwise specified. All wiring shall be copper conductors.
4. Terminal Blocks
- a. Terminal blocks shall be sized to accept wires terminating there on with a minimum of 250VAC rating at 15 amps. Terminal blocks shall be suitable for high rise DIN rail mounting. The blocks shall have a tin-plated copper alloy terminals and a marking surface for circuit identification.
 - b. Multilevel blocks shall be used for analog I/O shield terminations.
 - c. Multilevel common connection terminal blocks shall be used for DC circuit distribution.
 - d. All terminal blocks shall be from the same manufacturer.
5. Wiring Duct and Cover
- a. The wiring duct and cover shall be constructed of white rigid vinyl (PVC). The wiring duct shall have angled and interlocking lips to permit the duct cover to interlock with the duct. Wiring duct and covers shall be from the same manufacturer.
6. Control Panel Enclosure Heater
- a. The heater shall be designed for use in a control panel enclosure. The heater shall operate at 120VAC and sized (where required) to provide required heat for environment and component cold temperature specifications. The heater shall have an integral thermostat to automatically control the heater operation. The thermostat shall have minimum adjustment of 40 degrees F to 80 degrees F. The heater shall contain a ball bearing type fan that runs continuously. The heater shall be a self-contained metal housed unit.
7. Control Panel Thermostats – For Panel Temperature Alarm DI
- a. The control panel thermostat shall be a self-contained unit designed for use in control panel enclosures and DIN rail mounting. It shall have a minimum of one normally open contact rated for 120VAC at 1A inductive load. It shall have a minimum

set-point adjustment from 40 degrees F to 90 degrees F. The thermostat shall have screw type connections.

8. Control Relays
 - a. The control relay coil voltages shall be as indicated on the drawings. The relays shall be socket type terminals with a mating socket base. The socket base shall be suitable for DIN rail mounting and have pressure plate screw terminal connections. The relays shall have a minimum of two Form C contacts, rated for a minimum of 8 amps each at 120 VAC. The contacts shall be gold. The relay shall have an ON/OFF indicator. All control relays shall be from the same manufacturer.
9. Timer Relays - On Delay (Where Required)
 - a. The timer relay coil voltages shall be as indicated on the design drawings. The relays shall be socket type with a mating socket base. The socket base shall be suitable for DIN rail mounting and have pressure plate screw terminal connections. The relays shall have a minimum of two Form C contacts, rated for a minimum of 3 amps each at 120 VAC. The contacts shall be silver. The timing adjustment shall have a maximum on delay time of 200 seconds and a minimum on delay time of 1 second.
10. Control Panel Receptacle
 - a. The control panel receptacle shall be a 120VAC 15 AMP receptacle mounted inside the control panel enclosure and designed for panel mounting.
11. 120 VAC Single Pole Circuit Breakers
 - a. The single pole breakers shall be a thermal magnetic type rated for 10KA short circuit interrupt current at 120 Vac. The unit shall be rated for a minimum of 230VAC operating voltage and have a minimum electromechanical life of at least 20,000 cycles. The circuit breaker shall have finger and hand touch safe screw type connections and designed for DIN rail mounting. Trip curve as outlined in BOM. Single pole circuit breakers shall be from the same manufacturer.
12. 24 VDC Single Pole Circuit Breakers
 - a. The single pole breakers shall be a thermal magnetic type rated for 10KA short circuit interrupt current at 250 Vdc. The unit shall be rated for 125 Vdc and have a minimum electromechanical life of at least 20,000 cycles. The circuit breaker shall have finger and hand touch safe screw type connections and designed for DIN rail mounting. Single pole circuit breakers shall be from the same manufacturer.
13. Network Switch
 - a. The Ethernet switch shall have required number of ports plus quantity 4 spare RJ45 ports. RJ45 ports support a transmission speed of 10/100 Mbps with autodetect and negotiation. ST type TX/RX fiber ports as required to connect to other PLC and VFD panels. Unit is designed for direct DIN rail mount. The Ethernet switch power will be 24VDC. Rated for installation with adjacent components on the DIN rail without derating. MTBF greater than 80 years/700,000 hours at 25 Deg C operating. Minimum operating temperature range -10 Deg C to 60 Deg C.
14. 24 VDC Redundant Power Supplies
 - a. The 24 VDC power supplies shall be 120 Vac powered and provide 24 VDC and sized with 75% additional output current above the connected 24 VDC load. The 24 VDC output shall be adjustable from 24 to 28 Vdc. Maximum DC ripple of 50 mV peak to peak. Designed for direct DIN Rail mount. Rated at full current output up to an enclosure temperature of 40 Deg C. Designed to be installed with no air gap between adjacent power supplies and redundancy modules with a maximum of 40mm required space above and 20 mm required below the unit. Each individual

- power supply shall have dry contact output for power supply OK status. MTBF greater than 80 years/700,000 hours at 25 Deg C operating. Minimum operating temperature range -10 Deg C to 60 Deg C.
- b. The redundancy module shall be of the same manufacturer as the 24 VDC power supplies and designed to handle the current of the power supplies. The module shall use MOSFETs for reduced heat and voltage drop across the module. MTBF greater than 80 years/700,000 hours at 25 Deg C operating. Minimum operating temperature range -10 Deg C to 60 Deg C.
15. Uninterruptible Power Supply
 - a. The uninterruptible power supply shall be rated for 120VAC with a 1000VA capacity. The unit shall be a self-contained unit with a 6 foot, NEMA 5-15P male plug and a minimum of 4 battery/surge receptacles. The unit shall have an input voltage window from 80VAC to 150VAC for utility operation. The unit shall compensate for utility under-voltage (90VAC to 105VAC) by boosting the output. The unit shall compensate for utility over-voltage (125VAC to 140VAC) by decreasing the output. When running on battery the unit shall provide 115VAC output with a maximum +/- 8% allowable deviation at 60Hz with a maximum +/- 0.1 Hz deviation. The transfer time shall be a maximum of 4 ms. The unit shall have an online circuit breaker and internal battery internal current limiting. The batteries shall be a hot swappable, sealed, maintenance free lead acid type. The maximum recharge time shall be 5 hours from a completely discharged state. The unit shall have indicator lights for "online", "on battery", "ups overloaded" and "replace battery". There shall be an audible alarm for "on battery", "low battery" and "overload". The UPS shall have one alarm contact rated for a minimum of 1 amp at 120VAC. The alarm contact shall close when the UPS has an overload or faulty battery. The unit shall have full time EMI and RFI filtering and surge protection.
 - b. The unit dimensions shall be such that it is located on the bottom of the PLC panel enclosure and is easily removable by 120VAC cords and panel interior receptacle. No wiring required to swap or bypass.
 16. Control Panel Surge Suppressor
 - a. The surge suppressor shall be rated for an operating voltage of 120VAC at 30 amps and tested to meet the ANSI/IEEE C62.41 1991 and ANSI.IEEE C62.45 1987. It shall have a clamping voltage of 350 Volts or better on a category A3-200A ring wave test online to neutral and line to ground. It shall have a clamping voltage of 500 volts or better on a category C1-3000 amp impulse wave test on line to ground and neutral to ground. It shall have a minimum of 40db of EMI/RFI attenuation. The suppression unit shall not require scheduled maintenance or fuse replacement.
 17. Intrinsically Safe (IS) Barrier
 - a. Provide IS barriers for all devices and instruments terminating in the panel that are field located in classified areas. IS barrier shall be rated for field device type and signals. Provide cover over IS barrier on field wiring side.
 18. Control Panel Pushbuttons
 - a. The pushbuttons shall have a minimum of two normally open and two normally closed contacts rated for 7 amps at 120VAC. The contacts shall be field removable for future replacement. The unit shall be rated for a minimum of 1 million cycles. The pushbutton shall be a flush operator. The pushbuttons shall be rated for NEMA 4/4X. The pushbutton shall have a minimum diameter of 30mm, NEMA style.
 - b. Pilot lights, pushbuttons, and selector switches shall be from the same manufacturer.

- c. Provide front door mounted pushbuttons as required for operator manual control or resetting. Operator shall not be required to open the panel to clear alarms or control/start/stop devices.
19. Control Panel Pilot Lights
- a. The pilot lights shall be dual input LED cluster lamps. They shall have inline resistors and diodes to protect the LED lamp on both inputs to the lamp. The pilot light shall be rated for NEMA 4/4X. The pilot light shall have a minimum diameter of 30mm, NEMA style. The LED cluster and lens shall be of the same color. The led cluster and lens shall be field removable for future replacement. The color of the pilot light shall be as indicated on the panel layout drawings.
 - b. Pilot lights, pushbuttons, and selector switches shall be from the same manufacturer.
 - c. Provide front door mounted green run and red fault pilot lights for all motor starters and VFDs controlled by the respective MCP panel.
20. HOA Selector Switches
- a. The selector switches shall have a minimum of two normally open and two normally closed contacts rated for 7 amps at 120VAC. The contacts shall be field removable for future replacement. The unit shall be rated for a minimum of 1 million cycles. The unit shall be a three-position maintained operator. The units shall be rated for NEMA 4/4X and have a minimum diameter of 30mm, NEMA style.
 - b. Pilot lights, pushbuttons, and selector switches shall be from the same manufacturer.
 - c. Provide front door mounted green run and red fault pilot lights for all motor starters and VFDs controlled by the respective MCP panel.

2.4 PLC SYSTEM

A. PLC Hardware

- 1. All PLC hardware shall be Allen Bradley CompactLogix 5069 Family with 5380-LXXX processor - no exceptions.
- 2. Provide required PLC digital and analog I/O cards with 25% spare by card type.
- 3. Provide either Ethernet RJ45 port on the CompactLogix processor or via an Ethernet card in the chassis.
- 4. All PLC digital inputs shall be 24 VDC.
- 5. All digital outputs shall be CompactLogix Relay output cards. Relay outputs shall be wired to a respective DIN rail mounted control relay where controlling an isolated, separate power or AC circuit.
- 6. All PLC digital/analog inputs and outputs shall be terminated. This includes all unused inputs and outputs. All input and output devices connected to the PLC shall be terminated on the respective TB group for that card. Wiring to spare inputs and outputs shall bear the I/O number as the wire number.
- 7. Direct wiring of panel components and field devices on the PLC cards is not permitted.

B. HMI

- 1. HMI screen shall be NEMA 4X rated for front door mounting.
- 2. Operating temperature -20 Deg C to +50 Deg C

3. 7" color touch screen
 4. 10/100 Base Ethernet, 24 VDC, 80MB user memory
 5. Built in driver for Allen Bradley CompactLogix communications.
 6. Provide all required cables and pre-loaded development software and licenses for a complete and operational system.
 7. Contractor shall program, test and commission the HMI.
 8. PanelView Plus 7, Beijer, Red Lion or approved equivalent
- C. Programming of PLC and HMI
1. The Contractor shall provide all programming, functional testing and commissioning for the entire control system according to functional specifications and vendor specifications for a complete operating system.
 2. The programmer shall provide all required programming for a complete and functional control system.
 3. Adjustments or additional sequence interlocks, alarming, or minor graphic features added during FAT, commissioning and or SAT shall be included in the bid price.
 4. The Contractor shall provide all field technicians to execute the startup and functional checkouts and performance testing of the complete PLC control system.
- D. PLC & HMI Programming Software
1. Rockwell Studio 5000 Version 9.01 and HMI programming software are provided by the Contractor for Contractor use in developing the software applications for the project.

PART 3 - EXECUTION

3.1 GENERAL

- A. Install materials and equipment in a workman-like manner utilizing craftsmen skilled in the respective trade. Provide work which has a neat and finished appearance.
- B. Conduit penetrations are not permitted through the top of any enclosures or equipment.

3.2 MCP GENERAL

A. Grounding

1. The control panel enclosure, back panel and front door shall be grounded to the incoming ground bus using #14 green stranded wire. All internal and field ground wiring shall be grounded to the ground terminals. The ground terminals shall be grounded to the incoming ground bus using #14 green stranded wire.

B. Enclosure Cutouts

1. All new cutouts on the enclosures and doors shall be made with a hydraulic die-type knockout tool. Knockout size for mounting components shall be in accordance with the component manufacturers installation specifications. Knockouts for pushbuttons, pilot lights and selector switches shall be 2.75 inch centers.

2. Top penetrations of the panel enclosures are not permitted.
3. All cutouts shall be free from burrs, rough edges and damage. Incorrect cutouts compromising the respective NEMA ratings of the enclosure or impairing proper solid mounting of the respective component will require the Contractor to replace the door or enclosure. Repairs and are not acceptable.

C. Wiring Identification

1. All control wires shall be identified at both ends with numbers shown on the design drawings using heat shrinkable identification sleeves, computer generated black lettering on white sleeve. Handwritten wire numbering will not be accepted.

D. Nameplate Identification

1. All devices and equipment mounted on the removable back-panel shall have identification adjacent to each device. All nameplates shall be located to provide an unobstructed view of nameplate after wiring is complete. Do not mount nameplates on wireway covers.

E. Internal Panel Wire Routing

1. A.C. and D.C. wiring shall be kept separate as much as possible. All A.C. and D.C. control wire shall be terminated in terminal blocks. All shielded wire conductors shall be furnished before terminating with a slip-on crimp style pin terminal with an insulated grip. If a method of distributing strain on wire bent frequently such as those connected to devices on doors is not employed, extra flexible hinge wire shall be used.

3.3 PLC PROGRAMMING

A. The Contractor shall create the station CompactLogix PLC program based on the functional specifications and vendor functional specifications. The CompactLogix PLC program shall also provide as a minimum all the following features:

1. Logic, data and descriptions not relevant or used for the respective station shall be removed from each program prior to FAT and/or SAT.
2. Motor start/stop, sequence, interlocks, setpoints
3. Auto and Manual control
4. All Alarm and Events and qualification
5. Alarm interface with HMI and SCADA
6. Setpoint and Control interface from HMI and SCADA
7. The program shall be written in a fault tolerant manner to prevent frequent operator intervention. The program shall not require operator intervention on a PLC restart.
8. PLC shall monitor the Emergency Stop status and turn off all required motors via output cards or run/speed commands over Ethernet. Emergency Stop recovery program sequence shall be coordinated with Owner/Engineer for specific equipment requiring operator restart or a PLC automatic restart.
9. The program structure shall be divided into subroutines for each logical process and equipment group. Communication routines and data shall be in respective separate subroutines.
10. Communication interface and HMI/SCADA shall all be in respective separate subroutines.

11. All analog data values shall be scaled in the program. The scaled value shall represent the real final value. Scaling in the HMI and SCADA is not permitted.
12. Programs shall be written in ladder format. Programs shall be fully documented with rung and address comments. Comments at the start of new logic routines. Provide I/O listings, address, data usage and configuration printouts. All data table words shall have descriptions.

3.4 HMI & SCADA PROGRAMMING

- A. Screen graphics, details and layout shall take advantage of the screen size, resolution for a high level of detail on equipment and devices. Screens and functions shall be intuitive, text size easy to read. Navigation within and between screens shall be intuitive. Main overall station screen graphic shall be the default home screen. Dark screen saver shall be used for periods of inactivity greater than 30 minutes.
- B. The Contractor shall accurately depict equipment and devices for the respective station. Box or circle outlines representing equipment and devices or P&ID symbols will not be accepted. The contractor shall provide moving and/or color animation for all moving or rotating pieces of equipment, devices, and fluid flow including but not limited to: motors, pumps, fluids with flow status in pipes.
- C. Animation Color
 1. Screen animation color shall be as follows unless otherwise indicated:
 2. Instrumentation feedback in Alarm – Flashing Red
 3. Fault, Overload, or Alarm – Flashing Red
 4. Equipment or Device Running – Solid Green
 5. Equipment or Device Stopped – Solid Red
 6. Start Button – Solid Green
 7. Stop Button – Solid Red
 8. Valve Open - Solid Green
 9. Valve Closed – Solid Red
- D. Motor and Pump Control
 1. Provide control and status of AUTO/MANUAL modes and Manual Start/Stop. For VFD controlled equipment. Provide a Manual Mode speed setpoint in 0 to 60 Hz. Screen animation color shall be as outlined.
 2. Provide 24 hour and weekly motor run time totalizers for all motors. The 24 hour totalizers shall have a common administrator adjustable 24 hour totalizer reset time. All totalizers shall be trended and the ability to be exported as outlined in Data Storage and Exports.
- E. Common Screen Features
 1. Time and date
 2. Screen name
 3. Login/out button

4. Display the user name currently logged in
5. Station name
6. Navigation tree

F. Trend Screens

1. All PLC analog input values shall be viewable in real-time and historical with a trend display, plotting sampled data (Y-axis) vs. time (X-axis) in graphical format. Include navigation for time scrolling through the trend chart and entry box for selecting date and time. Include moveable scroll line that displays value.
2. Provide the ability to group PLC analog inputs in a common trend for analysis.

G. Alarming

1. Provide an alarm summary screen that displays the alarms in order as they occurred and the acknowledged or unacknowledged status. The alarm descriptions shall be concise so that the operator can understand the exact nature of the alarm condition. The time and date the alarm occurred shall be displayed for each alarm. Provide alarm acknowledging and alarm clearing features. Acknowledged points that are not in alarm shall automatically clear from the Alarm Summary.
2. Alarm Screen status color is as follows:
 - a. Red and flashing – unacknowledged and in alarm
 - b. Red and not flashing – acknowledged and in alarm
 - c. Blue – unacknowledged, was in alarm but cleared

H. Security

1. Screens shall be setup with Admin access for setpoint changes and a View user access for viewing only and acknowledging alarms.

3.5 FAT TESTING

A. General:

The contractor shall assemble and integrate the FAT at their facility to prove that the performance of the system satisfies all requirements of this project. The FAT shall take place during regular daytime working hours on weekdays within a minimum of 1 month prior to the project online date. Model numbers and software revisions shall be identical to those to be delivered to site. Original copies of data produced during the FAT, including results of each demonstration procedure, shall be delivered to the owner and or engineer at the conclusion of the test. The report shall be arranged so that commands, responses, and data acquired are correlated to allow logical interpretation of the data.

1. PLC's, HMI's, are communicating on the designated network(s)
2. PLC's are fully programmed and operational as specified
3. Actual or simulated field devices/equipment are configured to facilitate the testing.

- B. Create and submit an FAT test document for approval prior to scheduling and executing the FAT. The FAT test document shall be a spreadsheet including PLC & HMI CONTROL PANEL but not limited to the following columns: Action/Function Description, Expected Result, Actual Result, Pass Fail, Comments. The FAT test shall verify all the functional requirements including operator

setpoint changes, operator mode changes and demonstration of the sequence of operations by logical equipment grouping or program process. Alarming shall be tested including display, enable/disable, acknowledgement, and history log. The alarm testing shall be executed for each unique equipment or process alarm. For example, 2. demonstrate a "Motor Failed to Start" alarm for 1 motor. The following is required prior to scheduling or executing the FAT test.

1. Approved HMI screens and software
2. Approved PLC and hardware

3.6 SAT EXECUTION

A. General

The SAT shall take place during regular daytime working hours on weekdays within a minimum of 2 weeks prior to the project online date. Original copies of data produced during the SAT, including results of each demonstration procedure, shall be delivered to the owner and or engineer at the conclusion of the SAT. The report shall be arranged so that commands, responses, and data acquired are correlated to allow logical interpretation of the data.

B. Test Failure Assessment

1. If the test was stopped due to failures the Contractor shall identify the failures, determine causes of failures, repair failures, and deliver a written report to Owner. The report shall explain in detail the nature of each failure, corrective action taken, results of tests performed, and shall recommend the point at which the testing should be resumed. After delivering the written report, the Contractor shall convene a test review meeting at the job site to present the results and recommendations to the Owner. The meeting shall not be scheduled earlier than 5 business days after receipt of the report by the contracting officer. As a part of this test review meeting, the contractor shall demonstrate that the failure has been corrected. Based on the contractor's report and the test review meeting, Owner will determine the restart point, and may require the endurance test be totally or partially rerun. The Contractor shall not commence any required re-testing until after receipt of written notification by Owner.
2. The contractor will not be held responsible for failures resulting from the following: An outage of the main power supply in excess of the capability of any backup power source, provided that the automatic initiation of all backup sources was accomplished. Failure of existing equipment and existing instrumentation, provided that the failure was not due to contractor furnished equipment, installation, or software.

3.7 SCHEDULE

A. Control Panel List

Major Control Panel and Equipment List		
Panel #	Description	Note
MCP-001	WWTP SCADA PLC Main PLC Panel	TBD to Site Network
SCADA-001	SCADA System	CAT 6 to MCP-100A
MCP-100A	Raw Influent pump station Remote PLC panel	4 Pair Fiber to MCP-001
MCP-100B	Raw Influent pump station Motor Control Panel	CAT 6 to MCP-100A

MCP-125A	Grit Screen Remote PLC Panel	4 Pair Fiber to MCP-001
MCP-125B	Grit Screen Motor Control Panel	CAT 6 to MCP-125A

Major Control Panel and Equipment List (cont'd)		
Panel #	Description	Note
MCP-150A	Grit Removal Equipment Remote PLC Panel	4 Pair Fiber to MCP-001
MCP-150B	Grit Removal Equipment Motor Control Panel	CAT 6 to MCP-150A
MCP-200A	Oxidation Ditch Equipment Remote PLC panel	4 Pair Fiber to MCP-001
MCP-200B	Oxidation Ditch Equipment Motor Control Panel	CAT 6 to MCP-200A
MCP-350A	RAS/WAS Pump Station Remote PLC panel	4 Pair Fiber to MCP-001
MCP-350B	RAS/WAS Pump Station Motor Control Panel	CAT 6 to MCP-350A
MCP-400A	UV System Remote PLC panel	4 Pair Fiber to MCP-001
MCP-650A	Tertiary Filter Pump Station Remote PLC panel	4 Pair Fiber to MCP-001
MCP-650B	Tertiary Filter Pump Station Motor Control Panel	CAT 6 to MCP-650A
MCP-800A	Blower Master PLC Panel (Blowers 1-4)	4 Pair Fiber to MCP-001
MCP-800B	Blower Motor Control Panel (Blowers 1-4)	CAT 6 to MCP-800A
MCP-800C	Local Operator Panel (Blower 1)	CAT 6 to MCP-800A
MCP-800D	Local Operator Panel (Blower 2)	CAT 6 to MCP-800A
MCP-800E	Local Operator Panel (Blower 3)	CAT 6 to MCP-800A
MCP-800F	Local Operator Panel (Blower 4)	CAT 6 to MCP-800A
MCP-850A	Blower Master PLC Panel (Blowers 5-7)	4 Pair Fiber to MCP-001
MCP-850B	Blower Motor Control Panel (Blowers 5-7)	CAT 6 to MCP-850A
MCP-850C	Local Operator Panel (Blower 5)	CAT 6 to MCP-850A
MCP-850D	Local Operator Panel (Blower 6)	CAT 6 to MCP-850A
MCP-850E	Local Operator Panel (Blower 7)	CAT 6 to MCP-850A
MCP-900A	Aerobic Digesters No. 4 and 5: Remote PLC panel	4 Pair Fiber to MCP-001
MCP-900B	Aerobic Digesters No. 4 and 5: Motor Control Panel	CAT 6 to MCP-900A
MCP-950A	Sludge Transfer Pumps Remote PLC panel	4 Pair Fiber to MCP-001
MCP-950B	Sludge Transfer Pumps Motor Control Panel	CAT 6 to MCP-950A
MCP-1000A	Sludge Dewatering Feed Pumps & Grinder Remote PLC panel	4 Pair Fiber to MCP-001
MCP-1000B	Sludge Dewatering Feed Pumps & Grinder Motor Control Panel	CAT 6 to MCP-1000A
MCP-1025A	Polymer system Remote PLC panel	4 Pair Fiber to MCP-001
MCP-1025B	Dewatering Press Motor Control Panel Motor Control Panel	CAT 6 to MCP-1000A
MCP-1025C	Dewatering Press PLC Control Panel	4 Pair Fiber to MCP-001
MCP-1050A	Shaftless Conveyor Remote PLC panel	4 Pair Fiber to MCP-001
MCP-1050B	Shaftless Conveyor Motor Control Panel	CAT 6 to MCP-1050A
MCP-1080	Grinder Motor Control panel	Hardwired to SCADA PLC

END OF SECTION 409601

SECTION 409602 – CONTROL PANEL FOR INTERIOR LOCATIONS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, and Division-1 Specification sections apply to work of this section.
- B. This Section includes the general requirements for furnishing, installing, programming, adjusting, testing, documenting and commissioning of the complete and operational PLC based control system that is part of the Sunbury WWTP control system.
- C. Related Sections:
 - 1. Section 260010 – General Requirements
 - 2. Section 260020 - Demolition
 - 3. Section 260519 – Conductors
 - 4. Section 260526 – Grounding
 - 5. Section 409600 – PLC & SCADA Control System
 - 6. Section 409602 – Control Panel for Interior Locations

1.2 REFERENCE

- A. The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.
 - 1. IEEE C62.41 Surge Voltages in Low-Voltage AC Power Circuits
 - 2. National Electrical Manufacturers Association (NEMA)
 - 3. NEMA 250 Enclosures for Electrical Equipment (1000 Volts Maximum)
 - 4. NEMA AB 1 Molded Case Circuit Breakers and Molded Case Switches
 - 5. NEMA ICS 1 Industrial Controls and Systems
 - 6. NEMA ICS 2 Industrial Control Devices, Controllers and Assemblies
 - 7. NEMA ICS 4 Industrial Control and Systems: Terminal Blocks
 - 8. NEMA ICS 6 Enclosures for Industrial Control and Systems
 - 9. NEMA ST1 Standard for specialty transformers
 - 10. National Fire Protection Association (NFPA)
 - 11. NFPA 70 National Electrical Code
 - 12. NFPA 780 Installation of Lightning Protection Systems
 - 13. NFPA 810 Radio and Television Equipment
 - 14. UNDERWRITERS LABORATORIES (UL)
 - 15. UL 50 Enclosures for Electrical Equipment

16. UL 83 Thermoplastic-Insulated Wires and Cables
17. UL 94 Tests for Flammability of Plastic Materials for Parts in Devices and Appliances
18. UL 444 Standards for Communication Cables
19. UL 467 Grounding and Bonding Equipment
20. UL 486A Wire Connectors and Soldering Lugs for Use with Copper Conductors
21. UL 489 Molded-Case Circuit Breakers and Circuit-Breaker Enclosures
22. UL 508 The Standard for Industrial Control Equipment
23. UL 508A Outline of Investigation for Industrial Control Panels
24. UL 698 Industrial Control Equipment for Use in Hazardous (Classified) Locations
25. UL 886 Outlet Boxes and Fittings for Use in Hazardous Locations
26. UL 913 Intrinsically Safe Apparatus and Associated Apparatus for Use in Class I, II, and III, Division I Hazardous Locations
27. UL 1063 Machine Tool Wires and Cables
28. UL 1092 Process Control Equipment
29. UL 1203 Explosion Proof and Dust Ignition Proof Electrical Equipment for Use in Hazardous Locations
30. UL 1449 Standard for Transient Voltage Surge Suppression
31. UL 1604 Electrical Equipment for Use in Hazardous Locations, Class I and Class II, Division 2 and Class III, Divisions 1 and 2
32. UL 2225 Standard for Metal-Clad Cables and Cable Sealing Fittings for Use in Hazardous Locations
33. UL 2279 Electrical Equipment for Use in Class I, Zone 0, 1, and 2 Hazardous Locations

1.3 DEFINITION OF TERMS

- A. BOM – Bill of Materials
- B. IFB – Issued for Bid
- C. IFC – Issued for Construction
- D. FAT – Factory Acceptance Test
- E. HMI – Human Machine Interface
- F. MCC – Motor Control Center
- G. MCP (xxx) – Remote PLC Control Panels
- H. MCP 001 – SCADA PLC Control Panel
- I. MFG – Manufacturer

- J. OEM – Original Equipment Manufacturer
- K. O&M – Operations and Maintenance
- L. PLC – Programmable Logic Controller
- M. PS – Pump Station
- N. SAT – Site Acceptance Test
- O. SCADA – Supervisory Control and Data Acquisition system

1.4 SPECIAL REQUIREMENTS

- A. All Scope of Work shall be provided under the supervision of a single Contractor.
- B. The Contractor shall be specialized in the design, assembly, programming, testing, installation and service of PLC and SCADA control and communication systems for at least the last (8) eight years. Contractor shall provide supporting documentation with their bid demonstrating this requirement.
- C. The Contractor shall employ technical and professional staff with documented experience in the design, assembly, programming, testing, installation, operation, troubleshooting, and service of PLC, control and communication systems. Contractor shall provide supporting documentation with their bid demonstrating this requirement.
- D. The Contractor shall be experienced with the programming and commissioning of Allen Bradley/Rockwell PLC and HMI. Contractor shall provide supporting documentation with their bid demonstrating this requirement.
- E. The Contractor shall become familiar with all details of the work and verify any required dimensions and distances. Contractor shall determine network and interface wiring to/from; MCC, VFD Panels, vendor equipment and SCADA System, field instrumentation and field Devices. If any conflicts occur necessitating departures from the drawings, details of and reasons for departures shall be submitted and approved prior to implementing any change.

1.5 STANDARD PRODUCTS

- A. Material and equipment shall be a standard product of a manufacturer regularly engaged in the manufacture of the product and shall essentially duplicate items that have been in satisfactory use for at least (4) years prior to bid opening.

1.6 MATERIALS AND EQUIPMENT

- A. The label or listing of the Underwriters Laboratories, Inc., shall be accepted as evidence that the materials or equipment conform to the applicable standards of that agency. In lieu of this label or listing, a statement from a nationally recognized, adequately equipped testing agency indicating that the items have been tested in accordance with required procedures and that the materials and equipment comply with all contract requirements will be accepted. However, materials and equipment installed in hazardous locations must bear the UL label unless the data

submitted from other testing agency is specifically approved in writing by the owner. Materials and equipment shall be approved based on the manufacturer's published data. For other than equipment and materials specified to conform to UL publications, a manufacturer's statement indicating complete compliance with the applicable Federal Specification, or standard of the American Society for Testing and Materials, National Electrical Manufacturers Association, or other commercial standard, is acceptable.

1.7 RESPONSIBILITIES

- A. The Contractor shall be fully and completely responsible for all work performed and all materials installed under the contract. All contracts between the Contractor and subcontractor(s) shall conform to and meet all requirements specified in the contract documents.
- B. The Contractor shall be responsible for but not limited to:
 - 1. Contractor shall furnish and install the new PLC control system.
 - 2. Contractor shall create Rockwell Software PLC and HMI user programs for the PLC system as outlined.
 - 3. Contractor shall provide Submittals as outlined.
 - 4. Contractor shall coordinate and execute the FAT at their facility.
 - 5. Contractor shall coordinate and execute the SAT onsite.
 - 6. Contractor shall redline the IFC drawings with any changes made during FAT, SAT and operational testing and incorporate into As-Built set of drawings.
 - 7. Contractor shall provide recommend Spare Parts as outlined.
 - 8. Contractor to provide all electrical permits and inspections as required by the State, County, and City.
 - 9. Contractor shall provide onsite system training for the Owner. Training shall be on regular business days from 8 am to 3:00 pm.

1.8 SUBMITTALS

- A. Submit manufacturer's technical data and application instructions per Section 013323.
- B. Shop Drawings:
 - 1. Contractor shall submit manufacturers data sheets for Owner review and consideration of any material, parts or equipment substitutions/modifications prior to making a change.
- C. Submittals:
 - 1. Contractor shall prepare a complete shop drawing submittal of all (specified or substituted) components, devices, instruments and equipment, including fully detailed shop drawings, catalog cuts, wiring connections, and such other documentation as may be required to fully describe the equipment and to demonstrate its conformity to these plans and specifications. Catalog information shall be submitted for all components and equipment required for the project.
 - 2. All submittals shall be complete, organized, and indexed. Partial submittals will not be accepted. Submit (2) two hard copies and an electronic copy in pdf.

3. Owner review and approval is required on all shop drawings.

D. HMI Screen Submittals

1. The Contractor shall provide a pdf of all completed HMI screens required for review and approval prior to FAT execution. The screen shall represent the Contractor's final checked version and represent all the screens in the respective systems.

E. System Drawing Submittals

1. Following approval of the shop drawing submittals, the Contractor shall provide a complete sets of panel drawings including all redline markups (where executed). All drawing redlines shall be done using a pdf editor. Handwritten redlines and markups are not acceptable. Submit (2) two hard copies and an electronic copy in pdf.

F. FAT Test Plan

1. Contractor shall submit as outlined the (2) two hard copies and an electronic copy in pdf of the FAT plan and tests that will be executed.

G. SAT Test Plan

1. Contractor shall submit as outlined the (2) two hard copies and an electronic copy in pdf of the SAT plan and tests that will be executed.

1.9 OPERATION AND MAINTENANCE MANUALS

A. Provide Operation and Maintenance (O&M) data for the SCADA PLC system. Provide (3) three copies of the system O&M manual in a three-ring binder and in pdf electronic format. The O&M manual shall include:

1. All system equipment, components and device product cutsheets with actual part number and options highlighted.
2. control panel functions and indicator descriptions.
3. operations and procedures.
4. HMI color screen printouts of all screens with a function description of menus, operator control and input/output data.
5. Troubleshooting section for control procedures

1.10 SPARE PARTS

A. Spare parts shall be furnished as specified below. All spare parts shall be the same make, model, # and options as the respective approved part in the submittals. Spare parts shall be furnished new in OEM packaging.

1. PLC CPU (Qty. 1)
2. PLC Relay Output Card (Qty. 1 for each type used)
3. PLC Input Card (Qty. 1 for each type used)
4. PLC Analog Input Card (Qty. 2 for each type used)
5. PLC Analog Output Card (Qty. 1 each type used)

6. PLC Power Supplies (Qty. 1 of each type used)
7. Control Panel UPS (Qty. 1)
8. 24 Vdc Power Supply (Qty. 1)
9. 24 Vdc Redundant Power Supply Module (Qty. 1).

PART 2 - PRODUCTS

2.1 GENERAL

- A. Material shall be new, free from defects, and of the quality specified. All equipment and materials utilized in the system shall be the products of manufacturers with a minimum of (8) eight years of experience in the manufacture of similar equipment. Similar items in the system shall be the products of the same manufacturer. All equipment shall be of industrial grade and shall be specifically intended for control, monitoring and operation of motor-driven pumps and equipment. All equipment shall be of modular design to facilitate interchangeability of parts and to assure ease of servicing.

2.2 MAJOR EQUIPMENT LIST

- A. Provide all equipment and devices shown on the drawings and specified herein, including but not limited to, the following major Control System equipment:
 1. PLC System with HMI
 2. Rockwell ControlLogix 5000 and Rockwell FactoryTalk HMI Software Licenses

2.3 PLC CONTROL PANEL

- A. Similar items in the system shall be products from the same Manufacturer.
- B. Material shall be new, free from defects, and of the quality specified. All equipment shall be of industrial grade and of standard construction, shall be capable of long, reliable, trouble-free service, and shall be specifically intended for control and monitoring industrial equipment.
 1. Control Panel Identification Nameplates
 - a. Nameplates shall be furnished for all door mounted devices. Nameplates shall be duralith or micarta with black letters on white background. Letters shall be 3/16" high with seven (7) letters per inch, except where indicated otherwise. Engraving shall be done with a blunt tool to provide clear wide lines. Refer to design drawings for control panel front door nameplate schedule.
 - b. All components mounted on interior removable panel shall have identification adjacent to each device, using same material as paragraph above except black letters on yellow background. The nameplate shall identify the device and schematic device number. The nameplates shall be located to provide an unobstructed view of nameplate after wiring is complete. All identification nameplates shall have chamfered edges and fastened with stainless steel round head sheet metal screws.
 2. NEMA 4 Control Enclosure and Back-Panel

- a. NEMA 4 painted steel enclosure with lockable front door. Where enclosure is floor mounted, provide the corresponding painted steel stand kit intended from the enclosure manufacturer.
 - b. A removable white painted steel back panel shall be provided for the mounting of components. Panel shall be from the enclosure manufacturer and intended for enclosure size.
 - c. Saginaw or Hoffman
3. Control Wiring
- a. Wire shall be color coded as follows:
 - 1) AC Line & Load: Black
 - 2) AC Control: Red
 - 3) Neutral: White
 - 4) DC + Power: Blue
 - 5) DC Control: Blue
 - 6) DC - Common: White/blue stripe
 - 7) Mechanical Ground: Green or Green/Yellow Stripe
 - 8) Control Wiring Powered from Other Sources: Yellow
 - b. Conductor size shall be stranded #14 or larger (as required). All control, interface and power wire terminating in the panel shall be stranded wire type THHN, heavy wall except where otherwise specified. DC control wiring shall be stranded #16 AWG or larger (as required) except where otherwise specified.
 - c. All shielded cable shall be stranded #18 AWG with a 100% coverage shield and drain wire, 150-volt insulation except where otherwise specified. All wiring shall be copper conductors.
4. Terminal Blocks
- a. Terminal blocks shall be sized to accept wires terminating there on with a minimum of 250VAC rating at 15 amps. Terminal blocks shall be suitable for high rise DIN rail mounting. The blocks shall have a tin-plated copper alloy terminals and a marking surface for circuit identification.
 - b. Multilevel blocks shall be used for analog I/O shield terminations.
 - c. Multilevel common connection terminal blocks shall be used for DC circuit distribution.
 - d. All terminal blocks shall be from the same manufacturer.
5. Wiring Duct and Cover
- a. The wiring duct and cover shall be constructed of white rigid vinyl (PVC). The wiring duct shall have angled and interlocking lips to permit the duct cover to interlock with the duct. Wiring duct and covers shall be from the same manufacturer.
6. Control Panel Enclosure Heater
- a. The heater shall be designed for use in a control panel enclosure. The heater shall operate at 120VAC and sized (where required) to provide required heat for environment and component cold temperature specifications. The heater shall have an integral thermostat to automatically control the heater operation. The thermostat shall have minimum adjustment of 40 degrees F to 80 degrees F. The heater shall contain a ball bearing type fan that runs continuously. The heater shall be a self-contained metal housed unit.
7. Control Panel Thermostats – For Panel Temperature Alarm DI
- a. The control panel thermostat shall be a self-contained unit designed for use in control panel enclosures and DIN rail mounting. It shall have a minimum of one normally open contact rated for 120VAC at 1A inductive load. It shall have a minimum

set-point adjustment from 40 degrees F to 90 degrees F. The thermostat shall have screw type connections.

8. Control Relays
 - a. The control relay coil voltages shall be as indicated on the drawings. The relays shall be socket type terminals with a mating socket base. The socket base shall be suitable for DIN rail mounting and have pressure plate screw terminal connections. The relays shall have a minimum of two Form C contacts, rated for a minimum of 8 amps each at 120 VAC. The contacts shall be gold. The relay shall have an ON/OFF indicator. All control relays shall be from the same manufacturer.
9. Timer Relays - On Delay (Where Required)
 - a. The timer relay coil voltages shall be as indicated on the design drawings. The relays shall be socket type with a mating socket base. The socket base shall be suitable for DIN rail mounting and have pressure plate screw terminal connections. The relays shall have a minimum of two Form C contacts, rated for a minimum of 3 amps each at 120 VAC. The contacts shall be silver. The timing adjustment shall have a maximum on delay time of 200 seconds and a minimum on delay time of 1 second.
10. Control Panel Receptacle
 - a. The control panel receptacle shall be a 120VAC 15 AMP receptacle mounted inside the control panel enclosure and designed for panel mounting.
11. 120 VAC Single Pole Circuit Breakers
 - a. The single pole breakers shall be a thermal magnetic type rated for 10KA short circuit interrupt current at 120 Vac. The unit shall be rated for a minimum of 230VAC operating voltage and have a minimum electromechanical life of at least 20,000 cycles. The circuit breaker shall have finger and hand touch safe screw type connections and designed for DIN rail mounting. Trip curve as outlined in BOM. Single pole circuit breakers shall be from the same manufacturer.
12. 24 VDC Single Pole Circuit Breakers
 - a. The single pole breakers shall be a thermal magnetic type rated for 10KA short circuit interrupt current at 250 VDC. The unit shall be rated for 125 VDC and have a minimum electromechanical life of at least 20,000 cycles. The circuit breaker shall have finger and hand touch safe screw type connections and designed for DIN rail mounting. Single pole circuit breakers shall be from the same manufacturer.
13. Network Switch
 - a. The Ethernet switch shall have required number of ports plus quantity 4 spare RJ45 ports. RJ45 ports support a transmission speed of 10/100 Mbps with autodetect and negotiation. ST type TX/RX fiber ports as required to connect to other PLC and VFD panels. Unit is designed for direct DIN rail mount. The Ethernet switch power will be 24VDC. Rated for installation with adjacent components on the DIN rail without derating. MTBF greater than 80 years/700,000 hours at 25 Deg C operating. Minimum operating temperature range -10 Deg C to 60 Deg C.
14. 24 VDC Redundant Power Supplies
 - a. The 24 VDC power supplies shall be 120 Vac powered and provide 24 VDC and sized with 75% additional output current above the connected 24 VDC load. The 24 VDC output shall be adjustable from 24 to 28 Vdc. Maximum DC ripple of 50 mV peak to peak. Designed for direct DIN Rail mount. Rated at full current output up to an enclosure temperature of 40 Deg C. Designed to be installed with no air gap between adjacent power supplies and redundancy modules with a maximum of 40mm required space above and 20 mm required below the unit. Each individual

- power supply shall have dry contact output for power supply OK status. MTBF greater than 80 years/700,000 hours at 25 Deg C operating. Minimum operating temperature range -10 Deg C to 60 Deg C.
- b. The redundancy module shall be of the same manufacturer as the 24 VDC power supplies and designed to handle the current of the power supplies. The module shall use MOSFETs for reduced heat and voltage drop across the module. MTBF greater than 80 years/700,000 hours at 25 Deg C operating. Minimum operating temperature range -10 Deg C to 60 Deg C.
15. Uninterruptible Power Supply
 - a. The uninterruptible power supply shall be rated for 120VAC with a 1000VA capacity. The unit shall be a self-contained unit with a 6 foot, NEMA 5-15P male plug and a minimum of 4 battery/surge receptacles. The unit shall have an input voltage window from 80VAC to 150VAC for utility operation. The unit shall compensate for utility under-voltage (90VAC to 105VAC) by boosting the output. The unit shall compensate for utility over-voltage (125VAC to 140VAC) by decreasing the output. When running on battery the unit shall provide 115VAC output with a maximum +/- 8% allowable deviation at 60Hz with a maximum +/- 0.1 Hz deviation. The transfer time shall be a maximum of 4 ms. The unit shall have an online circuit breaker and internal battery internal current limiting. The batteries shall be a hot swappable, sealed, maintenance free lead acid type. The maximum recharge time shall be 5 hours from a completely discharged state. The unit shall have indicator lights for "online", "on battery", "ups overloaded" and "replace battery". There shall be an audible alarm for "on battery", "low battery" and "overload". The UPS shall have one alarm contact rated for a minimum of 1 amp at 120VAC. The alarm contact shall close when the UPS has an overload or faulty battery. The unit shall have full time EMI and RFI filtering and surge protection.
 - b. The unit dimensions shall be such that it is located on the bottom of the PLC panel enclosure and is easily removable by 120VAC cords and panel interior receptacle. No wiring required to swap or bypass.
 16. Control Panel Surge Suppressor
 - a. The surge suppressor shall be rated for an operating voltage of 120VAC at 30 amps and tested to meet the ANSI/IEEE C62.41 1991 and ANSI.IEEE C62.45 1987. It shall have a clamping voltage of 350 Volts or better on a category A3-200A ring wave test on line to neutral and line to ground. It shall have a clamping voltage of 500 volts or better on a category C1-3000 amp impulse wave test on line to ground and neutral to ground. It shall have a minimum of 40db of EMI/RFI attenuation. The suppression unit shall not require scheduled maintenance or fuse replacement.
 17. Intrinsically Safe (IS) Barrier
 - a. Provide IS barriers for all devices and instruments terminating in the panel that are field located in classified areas. IS barrier shall be rated for field device type and signals. Provide cover over IS barrier on field wiring side.
 18. Control Panel Pushbuttons
 - a. The pushbuttons shall have a minimum of two normally open and two normally closed contacts rated for 7 amps at 120VAC. The contacts shall be field removable for future replacement. The unit shall be rated for a minimum of 1 million cycles. The pushbutton shall be a flush operator. The pushbuttons shall be rated for NEMA 4/4X. The pushbutton shall have a minimum diameter of 30mm, NEMA style.
 - b. Pilot lights, pushbuttons, and selector switches shall be from the same manufacturer.

- c. Provide front door mounted pushbuttons as required for operator manual control or resetting. Operator shall not be required to open the panel to clear alarms or control/start/stop devices.
19. Control Panel Pilot Lights
- a. The pilot lights shall be dual input LED cluster lamps. They shall have inline resistors and diodes to protect the LED lamp on both inputs to the lamp. The pilot light shall be rated for NEMA 4/4X. The pilot light shall have a minimum diameter of 30mm, NEMA style. The LED cluster and lens shall be of the same color. The led cluster and lens shall be field removable for future replacement. The color of the pilot light shall be as indicated on the panel layout drawings.
 - b. Pilot lights, pushbuttons, and selector switches shall be from the same manufacturer.
 - c. Provide front door mounted green run and red fault pilot lights for all motor starters and VFDs controlled by the respective MCP panel.
20. HOA Selector Switches
- a. The selector switches shall have a minimum of two normally open and two normally closed contacts rated for 7 amps at 120VAC. The contacts shall be field removable for future replacement. The unit shall be rated for a minimum of 1 million cycles. The unit shall be a three-position maintained operator. The units shall be rated for NEMA 4/4X and have a minimum diameter of 30mm, NEMA style.
 - b. Provide front door mounted HOA for all motor starters and VFDs controlled by the respective MCP.

2.4 PLC SYSTEM

A. PLC Hardware

1. All PLC hardware shall be Allen Bradley CompactLogix 5069 Family with 5380-LXXX processor - no exceptions.
2. Provide required PLC digital and analog I/O cards with 25% spare.
3. Provide either Ethernet RJ45 port on the CompactLogix card or via a card in the chassis.
4. All PLC digital inputs shall be 24 VDC.
5. All digital outputs shall be CompactLogix Relay output cards. Relay outputs shall be wired to a respective DIN rail mounted control relay where controlling an isolated, separate power or AC circuit.
6. All PLC digital/analog inputs and outputs shall be terminated. This includes all unused inputs and outputs. All input and output devices connected to the PLC shall be terminated on the respective TB group for that card. Wiring to spare inputs and outputs shall bear the I/O number as the wire number.
7. Direct wiring of panel components and field devices on the PLC cards is not permitted.

B. HMI

1. HMI screen shall be NEMA 4 rated for front door mounting.
2. Operating temperature 0 Deg C to +50 Deg C
3. 9" color touch screen
4. 10/100 Base Ethernet, 24 VDC, 80MB user memory

5. Built in driver for Allen Bradley CompactLogix communications.
6. Provide all required cables and pre-loaded development software and licenses for a complete and operational system.
7. Contractor shall program, test and commission the HMI.
8. PanelView Plus 7, Beijer, Red Lion or approved equivalent

C. Programming of PLC and HMI

1. The Contractor shall provide all programming, functional testing and commissioning for the entire control system according to functional specifications and vendor specifications for a complete operating system.
2. The programmer shall provide all required programming for a complete and functional control system.
3. Adjustments or additional sequence interlocks, alarming, or minor graphic features added during FAT, commissioning and or SAT shall be included in the bid price.
4. The Contractor shall provide all field technicians to execute the startup and functional checkouts and performance testing of the complete PLC control system.

D. PLC & HMI Programming Software

1. Rockwell Studio 5000 Version 9.01 and FactoryTalk Machine Edition (ME) Version 11.0 programming software are provided by the Contractor for Contractor use in developing the software applications for the project.

PART 3 - EXECUTION

3.1 GENERAL

- A. Install materials and equipment in a workman-like manner utilizing craftsmen skilled in the respective trade. Provide work which has a neat and finished appearance.
- B. Conduit penetrations are not permitted through the top of any enclosures or equipment.

3.2 MCP GENERAL

A. Grounding

1. The control panel enclosure, back panel and front door shall be grounded to the incoming ground bus using #14 green stranded wire. All internal and field ground wiring shall be grounded to the ground terminals. The ground terminals shall be grounded to the incoming ground bus using #14 green stranded wire.

B. Enclosure Cutouts

1. All new cutouts on the enclosures and doors shall be made with a hydraulic die-type knockout tool. Knockout size for mounting components shall be in accordance with the component manufacturers installation specifications. Knockouts for pushbuttons, pilot lights and selector switches shall be 2.75 inch centers.
2. Top penetrations of the panel enclosures are not permitted.

3. All cutouts shall be free from burrs, rough edges and damage. Incorrect cutouts compromising the respective NEMA ratings of the enclosure or impairing proper solid mounting of the respective component will require the Contractor to replace the door or enclosure. Repairs and are not acceptable.

C. Wiring Identification

1. All control wires shall be identified at both ends with numbers shown on the design drawings using heat shrinkable identification sleeves, computer generated black lettering on white sleeve. Handwritten wire numbering will not be accepted.

D. Nameplate Identification

1. All devices and equipment mounted on the removable back-panel shall have identification adjacent to each device. All nameplates shall be located to provide an unobstructed view of nameplate after wiring is complete. Do not mount nameplates on wireway covers.

E. Internal Panel Wire Routing

1. A.C. and D.C. wiring shall be kept separate as much as possible. All A.C. and D.C. control wire shall be terminated in terminal blocks. All shielded wire conductors shall be furnished before terminating with a slip-on crimp style pin terminal with an insulated grip. If a method of distributing strain on wire bent frequently such as those connected to devices on doors is not employed, extra flexible hinge wire shall be used.

3.3 PLC PROGRAMMING

A. The Contractor shall create the station CompactLogix PLC program based on the functional specifications and vendor functional specifications. The CompactLogix PLC program shall also provide as a minimum all the following features:

1. Logic, data and descriptions not relevant or used for the respective station shall be removed from each program prior to FAT and/or SAT.
2. Motor start/stop, sequence, interlocks, setpoints
3. Auto and Manual control
4. All Alarm and Events and qualification
5. Alarm interface with HMI and SCADA
6. Setpoint and Control interface from HMI and SCADA
7. The program shall be written in a fault tolerant manner to prevent frequent operator intervention. The program shall not require operator intervention on a PLC restart.
8. PLC shall monitor the Emergency Stop status and turn off all required motors via output cards or run/speed commands over Ethernet. Emergency Stop recovery program sequence shall be coordinated with Owner/Engineer for specific equipment requiring operator restart or a PLC automatic restart.
9. The program structure shall be divided into subroutines for each logical process and equipment group. Communication routines and data shall be in respective separate subroutines.
10. Communication interface and HMI/SCADA shall all be in respective separate subroutines.

11. All analog data values shall be scaled in the program. The scaled value shall represent the real final value. Scaling in the HMI and SCADA is not permitted.
12. Programs shall be written in ladder format. Programs shall be fully documented with rung and address comments. Comments at the start of new logic routines. Provide I/O listings, address, data usage and configuration printouts. All data table words shall have descriptions.

3.4 HMI & SCADA PROGRAMMING

- A. Screen graphics, details and layout shall take advantage of the screen size, resolution for a high level of detail on equipment and devices. Screens and functions shall be intuitive, text size easy to read. Navigation within and between screens shall be intuitive. Main overall station screen graphic shall be the default home screen. Dark screen saver shall be used for periods of inactivity greater than 30 minutes.
- B. The Contractor shall accurately depict equipment and devices for the respective station. Box or circle outlines representing equipment and devices or P&ID symbols will not be accepted. The contractor shall provide moving and/or color animation for all moving or rotating pieces of equipment, devices, and fluid flow including but not limited to: motors, pumps, fluids with flow status in pipes.
- C. Animation Color
 1. Screen animation color shall be as follows unless otherwise indicated:
 2. Instrumentation feedback in Alarm – Flashing Red
 3. Fault, Overload, or Alarm – Flashing Red
 4. Equipment or Device Running – Solid Green
 5. Equipment or Device Stopped – Solid Red
 6. Start Button – Solid Green
 7. Stop Button – Solid Red
 8. Valve Open - Solid Green
 9. Valve Closed – Solid Red
- D. Motor and Pump Control
 1. Provide control and status of AUTO/MANUAL modes and Manual Start/Stop. For VFD controlled equipment. Provide a Manual Mode speed setpoint in 0 to 60 Hz. Screen animation color shall be as outlined.
 2. Provide 24 hour and weekly motor run time totalizers for all motors. The 24-hour totalizers shall have a common administrator adjustable 24-hour totalizer reset time. All totalizers shall be trended and the ability to be exported as outlined in Data Storage and Exports
- E. Common Screen Features
 1. Time and date
 2. Screen name
 3. Login/out button

4. Display the user name currently logged in
5. Station name
6. Navigation tree

F. Trend Screens

1. All PLC analog input values shall be viewable in real-time and historical with a trend display, plotting sampled data (Y-axis) vs. time (X-axis) in graphical format. Include navigation for time scrolling through the trend chart and entry box for selecting date and time. Include moveable scroll line that displays value.
2. Provide the ability to group PLC analog inputs in a common trend for analysis

G. Alarming

1. Provide an alarm summary screen that displays the alarms in order as they occurred and the acknowledged or unacknowledged status. The alarm descriptions shall be concise so that the operator can understand the exact nature of the alarm condition. The time and date the alarm occurred shall be displayed for each alarm. Provide alarm acknowledging and alarm clearing features. Acknowledged points that are not in alarm shall automatically clear from the Alarm Summary.
2. Alarm Screen status color is as follows:
 - a. Red and flashing – unacknowledged and in alarm
 - b. Red and not flashing – acknowledged and in alarm
 - c. Blue – unacknowledged, was in alarm but cleared

H. Security

1. Screens shall be setup with Admin access for setpoint changes and a View user access for viewing only and acknowledging alarms.

3.5 FAT TESTING

A. General:

The contractor shall assemble and integrate the FAT at their facility to prove that the performance of the system satisfies all requirements of this project. The FAT shall take place during regular daytime working hours on weekdays within a minimum of 1 month prior to the project online date. Model numbers and software revisions shall be identical to those to be delivered to site. Original copies of data produced during the FAT, including results of each demonstration procedure, shall be delivered to the owner and or engineer at the conclusion of the test. The report shall be arranged so that commands, responses, and data acquired are correlated to allow logical interpretation of the data.

1. PLC's, HMI's, are communicating on the designated network(s)
2. PLC's are fully programmed and operational as specified
3. Actual or simulated field devices/equipment are configured to facilitate the testing.

- B. Create and submit an FAT test document for approval prior to scheduling and executing the FAT. The FAT test document shall be a spreadsheet including PLC & HMI CONTROL PANEL but not limited to the following columns: Action/Function Description, Expected Result, Actual Result, Pass Fail, Comments. The FAT test shall verify all the functional requirements including operator

setpoint changes, operator mode changes and demonstration of the sequence of operations by logical equipment grouping or program process. Alarming shall be tested including display, enable/disable, acknowledgement, and history log. The alarm testing shall be executed for each unique equipment or process alarm. For example, 2. demonstrate a “Motor Failed to Start” alarm for 1 motor. The following is required prior to scheduling or executing the FAT test.

1. Approved HMI screens and software
2. Approved PLC and hardware

3.6 SAT EXECUTION

A. General

The SAT shall take place during regular daytime working hours on weekdays within a minimum of 2 weeks prior to the project online date. Original copies of data produced during the SAT, including results of each demonstration procedure, shall be delivered to the owner and or engineer at the conclusion of the SAT. The report shall be arranged so that commands, responses, and data acquired are correlated to allow logical interpretation of the data.

B. Test Failure Assessment

1. If the test was stopped due to failures the Contractor shall identify the failures, determine causes of failures, repair failures, and deliver a written report to Owner. The report shall explain in detail the nature of each failure, corrective action taken, results of tests performed, and shall recommend the point at which the testing should be resumed. After delivering the written report, the Contractor shall convene a test review meeting at the job site to present the results and recommendations to the Owner. The meeting shall not be scheduled earlier than 5 business days after receipt of the report by the contracting officer. As a part of this test review meeting, the contractor shall demonstrate that the failure has been corrected. Based on the contractor's report and the test review meeting, Owner will determine the restart point, and may require the endurance test be totally or partially rerun. The Contractor shall not commence any required re-testing until after receipt of written notification by Owner.
2. The contractor will not be held responsible for failures resulting from the following: An outage of the main power supply in excess of the capability of any backup power source, provided that the automatic initiation of all backup sources was accomplished. Failure of existing equipment and existing instrumentation, provided that the failure was not due to contractor furnished equipment, installation, or software.

3.7 SCHEDULE

A. Control Panel List

Panel #	Description	Note
MCP-001	WWTP SCADA PLC Main PLC Panel	TBD to Site Network
SCADA-001	SCADA System	CAT 6 to MCP-100A
MCP-100A	Raw Influent pump station Remote PLC panel	4 Pair Fiber to MCP-001
MCP-100B	Raw Influent pump station Motor Control Panel	CAT 6 to MCP-100A

MCP-125A	Grit Screen Remote PLC Panel	4 Pair Fiber to MCP-001
MCP-125B	Grit Screen Motor Control Panel	CAT 6 to MCP-125A
MCP-150A	Grit Removal Equipment Remote PLC Panel	4 Pair Fiber to MCP-001
MCP-150B	Grit Removal Equipment Motor Control Panel	CAT 6 to MCP-150A

Major Control Panel and Equipment List		
Panel #	Description	Note
MCP-200A	Oxidation Ditch Equipment Remote PLC panel	4 Pair Fiber to MCP-001
MCP-200B	Oxidation Ditch Equipment Motor Control Panel	CAT 6 to MCP-200A
MCP-350A	RAS/WAS Pump Station Remote PLC panel	4 Pair Fiber to MCP-001
MCP-350B	RAS/WAS Pump Station Motor Control Panel	CAT 6 to MCP-350A
MCP-400A	UV System Remote PLC panel	4 Pair Fiber to MCP-001
MCP-650A	Tertiary Filter Pump Station Remote PLC panel	4 Pair Fiber to MCP-001
MCP-650B	Tertiary Filter Pump Station Motor Control Panel	CAT 6 to MCP-650A
MCP-800A	Blower Master PLC Panel (Blowers 1-4)	4 Pair Fiber to MCP-001
MCP-800B	Blower Motor Control Panel (Blowers 1-4)	CAT 6 to MCP-800A
MCP-800C	Local Operator Panel (Blower 1)	CAT 6 to MCP-800A
MCP-800D	Local Operator Panel (Blower 2)	CAT 6 to MCP-800A
MCP-800E	Local Operator Panel (Blower 3)	CAT 6 to MCP-800A
MCP-800F	Local Operator Panel (Blower 4)	CAT 6 to MCP-800A
MCP-850A	Blower Master PLC Panel (Blowers 5-7)	4 Pair Fiber to MCP-001
MCP-850B	Blower Motor Control Panel (Blowers 5-7)	CAT 6 to MCP-850A
MCP-850C	Local Operator Panel (Blower 5)	CAT 6 to MCP-850A
MCP-850D	Local Operator Panel (Blower 6)	CAT 6 to MCP-850A
MCP-850E	Local Operator Panel (Blower 7)	CAT 6 to MCP-850A
MCP-900A	Aerobic Digesters No. 4 and 5: Remote PLC panel	4 Pair Fiber to MCP-001
MCP-900B	Aerobic Digesters No. 4 and 5: Motor Control Panel	CAT 6 to MCP-900A
MCP-950A	Sludge Transfer Pumps Remote PLC panel	4 Pair Fiber to MCP-001
MCP-950B	Sludge Transfer Pumps Motor Control Panel	CAT 6 to MCP-950A
MCP-1000A	Sludge Dewatering Feed Pumps & Grinder Remote PLC panel	4 Pair Fiber to MCP-001
MCP-1000B	Sludge Dewatering Feed Pumps & Grinder Motor Control Panel	CAT 6 to MCP-1000A
MCP-1025A	Polymer system Remote PLC panel	4 Pair Fiber to MCP-001
MCP-1025B	Dewatering Press Motor Control Panel	CAT 6 to MCP-1000A
MCP-1025C	Dewatering Press PLC Control Panel	4 Pair Fiber to MCP-001
MCP-1050A	Shaftless Conveyor Remote PLC panel	4 Pair Fiber to MCP-001
MCP-1050B	Shaftless Conveyor Motor Control Panel	CAT 6 to MCP-1050A
MCP-1080	Grinder Motor Control panel	Hardwired to SCADA PLC

END OF SECTION 409602

SECTION 431133 - ROTARY LOBE BLOWERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specifications sections, apply to work of this section.
- B. References
 - 1. American Society of Testing and Materials (ASTM)
 - 2. National Electrical Manufacturers Association (NEMA)
 - 3. Occupational Safety and Health Act (OSHA)
 - 4. National Electrical Code (NEC)
 - 5. American Gear Manufacturers Association (AGMA)
 - 6. Anti-Friction Bearing Manufacturers Association (AFBMA)
 - 7. International Organization of Standardization (ISO)
 - 8. International Electrotechnical Commission (IEC)
 - 9. German Institute for Standardization (DIN)

1.2 DESCRIPTION OF WORK

- A. This section includes the furnishing and installation total of seven (7) positive displacement rotary screw lobe blowers and all pertinent accessories, complete and in place, ready for service as shown on the Drawings and described in this section, of which:
 - 1. Four (4) positive displacement rotary screw lobe blower, Blowers No. 1-4, shall be installed in the existing blower shed located at the Sludge Transport / Electrical Building for the Aerobic Digesters No. 1-3, Sludge Wet Well No. 1 & 2, and Post Aeration air supply.
 - 2. Three (3) positive displacement rotary screw lobe blower, Blowers No. 5-7, shall be installed in the new constructed blower shed located at the Aerobic Digesters No. 4 & 5.
- B. Each of the blowers shall be furnished complete with positive displacement screw lobe blower, electric motor, inlet and discharge expansion joints, discharge check valve, discharge butterfly valve with operator, inlet and discharge silencers, filter, pressure relief valve, anchor bolts, and all other accessories required for satisfactory operation.
- C. All equipment provided under this Specification shall be furnished by a single system Supplier who shall be responsible through the Contractor for the completeness, compatibility of all included equipment, performance, adequacy and proper operation of the system in accordance with the requirements herein. The Contractor through the Supplier shall guarantee and shall be the source of information for the complete system, including each piece of equipment furnished under this Section and other Sections, regardless of the manufacturing source of that equipment.

1.3 QUALITY ASSURANCE

- A. In addition to requirements of these specifications, comply with manufacturer's instructions and recommendations for work.

- B. The equipment manufacturers listed shall have a minimum of ten (10) years of experience of producing the specified equipment and shall be able to show evidence of at least ten (10) installations in satisfactory operation for at least five years in the United States.
- C. All materials shall be new and of the best quality. The equipment specified herein shall be the design and fabrication of a single manufacturer which shall have sole source responsibility for this equipment.
- D. Rotary Lobe Compressor Packages shall be designed to minimize the life-cycle costs and maximize plant reliability. The design and the selection of the components shall be based on a minimum useful life of 20 years of continuous operation and a Mean Time Between Overhauls of 5 years of continuous operation. Bearing life shall be submitted by manufacturer of the blower stage, based on specified conditions.
- E. Factory Test:
 - 1. Each rotary lobe compressor stage shall be factory performance tested in accordance with ISO 1217 standards to verify flow and brake horsepower. A slip test shall not be acceptable, nor is average data for the manufactured size.
 - 2. The acceptance criteria are +5% tolerance on power and -5% tolerance on flow regardless of the size of the machine, per ISO 1217 tolerances.
 - 3. The manufacturer shall submit free field noise data for the complete blower package. The results shall be obtained using an ISO 2151 method of measurement. The performance data shall include a Declaration of Conformity, per Machinery Directive 2006/42/EC, Annex II, No.1 A.
 - 4. All critical dimensions of the blower components provided by the manufacturer shall be verified and documented prior to assembly.
 - 5. Each blower provided by the manufacturer shall be operated at its maximum rated speed and differential pressure for fifteen (15) minutes.
 - 6. On completion of final assembly of the packaged blower and prior to shipment, each packaged blower shall be mechanically run for a minimum of thirty (30) minutes.
 - 7. Manufacturer shall guarantee that the rotary lobe compressor shall provide oil-free operation and be certified to ISO 8573-1 Class Zero.

1.4 SUBMITTALS

- A. Submit manufacturer's technical data and application instructions per Section 013323.
- B. Product Data: Submit manufacturer's technical data and application instructions.
 - 1. Complete Performance Data at the Design Point and all specified operating points including:
 - a. A complete and detailed list of any and all variations to the specification
 - b. Descriptive literature, bulletins, and/or catalog cut sheets of the equipment
 - c. Scope of supply
 - d. Blower system performance data sheets, including following:
 - 1) Design inlet conditions, pressure, temperature and RH%,
 - 2) Capacity - scfm and icfm at discharge pressure
 - 3) Discharge pressure
 - 4) Descriptive literature, bulletins, and/or catalog cut sheets of the equipment
 - 5) Actual Operating Speed (RPM) and % of maximum rated speed
 - 6) Process air connection size
 - 7) Blower shaft HP, motor HP and motor data

- 8) Operating Voltage
 - 9) dB(A) noise and pressure level.
 - e. Package weight
 - f. Pressure relief valve set point
 - g. Performance curves for VFD applications
 - h. Discharge temperature
 - i. List of accessories being supplied
 - j. Paint specification
2. Certified results from tests conducted in accordance with the ISO 1217 Power Test Code for Compressors and Exhausters.
 3. Manufacturer's standard performance curve showing blower rpm, pressure differential, capacity in ICFM, blower shaft horsepower, temperature rise at standard conditions.
- C. Shop Drawings:
1. General arrangement drawings showing materials, details of construction, dimensions and connections.
 2. Blower system drawing showing all important details required for installation including dimensions, anchor bolt locations, size and location of connections to other works and weight of equipment.
 3. Indicate plan and section layout of blowers and ancillary equipment, dimensions, clearances required, inlet and outlet connections, power requirements, and wiring diagrams.
 4. Electrical diagrams and connections
 5. Instrumentation and Wiring Diagram
 6. Control panel layouts (front and subpanel) and bill of material listing.
- D. Operation and Maintenance: Complete blower package operating and maintenance instructions. The maintenance manuals shall contain copies of the approved shop drawings, operating and greasing instructions, parts list, including (but not limited to):
1. Blower startup checklist
 2. List of recommended spare parts broken down into on hand parts and long term for 2, 3 and 5 years operation.
 3. MSDS sheet (oil)
 4. Lubrication requirement
 5. Warranty information

1.5 WARRANTY

- A. The manufacturer shall warrant the bare blowers being supplied against all defects in workmanship and materials for a period of twenty-four (24) months from date of startup, not to exceed thirty (30) months from the date of shipment from the manufacturer of the blowers. .
- B. The contractor shall be responsible for proper storage of the equipment so as to remain in "as shipped" condition. If the equipment remains in storage at the job site for longer than six (6) months before installation, the contractor shall provide factory service personnel for a complete inspection of the equipment. Any work necessary to restore the equipment to "as shipped" condition shall be the responsibility of the Contractor

1.6 DELIVERY, STORAGE AND HANDLING

- A. All equipment shall be completely factory assembled, skid mounted, crated and delivered to protect against damage during shipment.
- B. All exposed flanges shall be covered and sealed with shrink-wrap to prevent the entrance of moisture. Finished iron or steel surfaces not painted shall be properly protected to prevent rust and corrosion.
- C. All equipment delivered to the site shall be stored as specified in accordance with the manufacturer's instructions.

1.7 SPARE PARTS

- A. Furnish the following manufacturer's recommended routine maintenance spare parts for each blower provided:
 - 1. Two (2) filter elements for integral inlet silencer
 - 2. Lubrication for first year of operation
 - 3. One (1) set of V-belts (if applicable)
 - 4. Two (2) fuses of each type supplied
- B. Furnish the following recommended routine maintenance spare parts for each control panel provided:
 - 1. Two (2) spare fuses for each type used in the control panel.
 - 2. Two (2) spare bulbs for each type of light in the control panel

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Subject to compliance with specified requirements, supply the rotor lobe blowers from one of the following manufacturers:
 - 1. Aerzen
 - 2. Kaeser
 - 3. Or approved equal.

2.2 EQUIPMENT

- A. No special foundations shall be required. The packages shall be installed directly on a concrete slab without grouting the base frame. There shall only be 4 easily accessible anchor points.
 - 1. The blower shall be of the of the positive displacement rotary lobe type, with design features for pulsation reduction (either pulsation cancellation channels or twisted lobes). And must provide oil-free air, suitable for heavy-duty continuous industrial service.
 - 2. Each assembly shall be rugged in construction and of such design that it may be disassembled and inspected without disturbing the inlet or discharge piping.
- B. Blower Casing
 - 1. The casing shall be of one-piece construction, with separate side plates that are bolted and pinned to the housing.

2. Casing materials shall be close-grained cast iron ASTM A48 , or EN GJL-200 suitably ribbed to prevent distortion under the specified operating conditions.
3. Inlet and outlet shall be flanged connections or drilled and tapped for studs to allow solid connection of mating surface.
4. Airflow shall be vertical top to bottom with inlet and outlet connections offset so that the flow travel horizontally across the blower stage. Casings that do not utilize a horizontal internal flow shall not be allowed.
5. The vibration level as measured at the casing, in the X/Y planes of the bearings, shall not exceed 0.3 inch/sec RMS when operating at the specified operating pressure and speed. The vibration level shall be checked at start-up and documented in the field start up report.

C. Rotors

1. Each rotor (male and female) shall be of the "stiff" design with first lateral critical speed at least 120% of the maximum allowable operating speed.
2. The rotors shall operate without rubbing nor shall they require lubrication.
3. Rotors shall be drop forged in one single piece of AISI 1043 or equivalent, machined to final tolerance. Minimum material tensile strength shall be 620 Mpa. Lesser precision cast iron rotors with surface coatings shall NOT be accepted.
4. Open rotors shall not be acceptable.
5. For maximum strength and reliability, the female rotor shall be driven by the drive motor and the male rotor shall be driven by the timing gear set. Stages that utilize a male driven rotor shall not be accepted.
6. A male and female rotor configuration with internal compression ratio and axial flow entry must be used to increase the adiabatic efficiency of the blower stage. Twisted rotor profiles applied for pulsation cancelation only shall not be allowed. Radial flow entry type rotors shall not be allowed.
7. Only precision-machined rotors with sealing strips to optimize clearance and performance shall be accepted.
8. Rotors shall be statically and dynamically balanced per ISO1940/ANSI S2.19 G2.5.

D. Bearings

1. Each rotor/shaft shall be supported by anti-friction bearings and fixed to control the axial location of the rotor/shaft in the unit.
2. The bearings shall be sized for a minimum expected life of 5 years between overhauls.
3. The applied design conditions shall yield a bearing load and minimal L-10 bearing life calculation of 100,000 hrs. Calculated bearing life shall be submitted, based on specified operating conditions.

E. Timing Gears

1. The rotors shall be timed by a pair of single helical or straight cut gears with quality equivalent to AGMA 12. Spur cut gears shall not be acceptable.
2. Gears shall have hardened and ground teeth and a minimum AGMA service factor of 1.70.
3. Gears shall be mounted via hydraulic expansion onto the shafts with a tapered interference fit and secured by a locknut or the timing gear set and shall be taper-mounted on the rotors. Pinned gears shall not be acceptable.

F. Seals

1. Seals shall be designed to prevent lubricant from leaking into the air stream as well as to prevent oil from leaking out of the machine.

2. The seal shall be a cartridge type a noncontact labyrinth seal with no wearing parts on the oil end. Internal lip seals shall not be permitted.
3. The rotor input shaft shall have a noncontact labyrinth seal with no wearing parts. The input drive shaft seal shall be a sliding ring type mechanical seal that will prevent oil leakage from where the input shaft goes thru the drive end cover plate.

G. Lubrication

1. The timing gears and the bearings shall be oil lubricated. Grease lubrication shall be not acceptable.

H. Oil Sight Glass:

1. An oil sight glass shall be provided on the exterior of the noise enclosure so the operator can easily view the oil level.
2. Also, the oil chamber with a domed design sight glass to allow visual inspection of oil level and oil condition, viewable from the front of the blower block, inside of the enclosure shall be allowed when oil level is also monitored by the integral controller.

2.3 ACCESSORIES

A. Inlet Filter / Silencer:

1. Each package shall be supplied with one combination inlet filter and silencer.
2. The inlet filter silencer shall be mounted directly to the inlet flange of the blower.
3. The filter media efficiency shall meet the requirements of ASHRAE 52.2 MERV7 50-70% @3-10 microns corresponding to EN779 G4.
4. The silencer portion shall be located upstream of the inlet filter.
5. The filter element shall be designed to trap dirt on the inside so that upon changing, dirt does not fall into the machinery. Filters where dirt accumulates on the external surface of the filter shall not be permitted.
6. Filter and silencer performance losses (clean element) shall be included in the entire package performance calculation.

B. Base Frame / Discharge Silencer:

1. Each package shall be supplied with two-pieces or one combination base frame / discharge silencer.
2. Discharge Silencer
 - a. The silencer shall be a chamber type design for maximum sound attenuation or combination type of adsorption, reflection and diffusion type.
 - b. The design of combination type discharge silencer shall incorporate a solid outer and perforated inner cylinder with adsorptive material in between the cylinders. Absorptive material shall be long, flexible, knotted polyester fibers.
3. The silencer shall be fabricated of a single shell of pressure vessel quality steel with continuous welds.
4. The silencer must be subject to a pressure test for tightness and strength at a minimum of 1.65 times the maximum design pressure.
5. The silencer shall have a machined flanged inlet connection and bolt directly to the discharge flange of the rotary lobe compressor or mount to blower discharge port via flexible type connector. Inlet and discharge ports shall be drilled and tapped for studs to allow solid connection of mating surfaces.

6. Discharge silencer performance losses shall be included in the entire package pressure calculation. Blower accessories shall be supplied by the manufacturer of the blower stage.
7. The base frame shall be constructed from welded carbon steel that shall be designed to maintain alignment of the blower internal components and the drive during operation.
8. The base frame shall be designed to resist distortion while being installed on vibration isolating mounts.
9. The manufacturer shall supply a stainless-steel grounding lug fully welded to the base or a ground wire shall be installed between the blower base and the sound enclosure base to allow for grounding of the complete blower package.

C. Flexible Connectors:

1. Each package shall be provided with a flexible ANSI style discharge connector or a web reinforced silicone rubber sleeve with corrosion resistant clamps.
 - a. Flexible connectors shall prevent the transmission of noise and vibrations from the blower package into the piping.
 - b. Flexible discharge connectors shall be Proco Style 240, Type EE, EPDM, with a standard ANSI flange discharge connection, rated for 300 °F at 20 psig. Soft face range with galvanized split ring reinforcement.

D. Electric Motor:

1. Each package shall be supplied with a WEG or Siemens manufactured TEFC NEMA Premium Efficiency motor that shall operate on 460 Volts, 3 Phase, 60 Hertz current, 3600 RPM. Operation of motors above 60 Hertz shall not be allowed under any circumstance.
2. Motors shall be horizontal, foot mounted, rigid base, Torque NEMA B, Temperature rise Class B, TEFC IP55, in a watertight and dust tight enclosure.
3. Class F, inverter rated insulation, Class H applied varnish, 3:1 constant torque VFD-duty.
4. Regreasable bearings, positive pressure lubrication system with automatic drain plugs – pressure compensated (frame sizes 254T and larger).
5. All frame sizes shall be domestic NEMA standard frame sizes, suitable for overhung belt drive or gear driven and with the conduit box on top of the motor. IEC frame motors shall not be allowed.
6. The motor shall be mounted on a pivoting base to provide automatic tensioning of the belts or gear driven. The motor nominal rating after any corrections for ambient conditions shall be 10% above the maximum operating horsepower.
7. The motor shall have a 1.15 service factor.
8. Motor windings shall be supplied with a normally closed thermostat, one per phase, wired in series to form a fail-safe motor protection circuit for the external fault circuit of the motor controller on all frame sizes at or above 324T. Thermal motor protection shall be Pt100 resistance.
9. If the motor is VFD driven, the motors shall be equipped with an Aegis ring to mitigate the effects of stray motor currents.
10. Blower manufacturer shall be responsible for coordinating the starting torque requirement of the blower and the motor.
11. The use of the TEFC motor to cool the blower system or circulate the enclosure air shall not be allowed.
12. Regardless of VFD supply, the manufacturer shall publish the VFD program settings in the submittal documentation to verify operation is within the intended RPM range of the motor.
13. Under no circumstances shall operation above 60Hz be permitted to achieve the required flow rate. Motor operation shall be limited to a maximum of 60Hz by the motor controller.

- E. V-Belt Drive (if applicable):
1. Each package shall be supplied with a V-belt drive that shall be of the high-capacity type, oil, and heat resistant.
 2. Drive shall be designed for a minimum service factor of 1.4 times operating power (bHp), or 1.1 times the motor nameplate Hp, whichever is larger to allow a minimum of 1.4-service factor based on the maximum blower bHp.
 3. Belt tensioning shall be automatic without the use of any spring devices or interaction on the part of the operator. Slide rails or spring tensioners shall not be used as a tensioning device.
 4. Sheaves shall be dynamically balanced regardless of the operating speed and hydraulically mounted on the compressor drive shaft.
 5. The automatic tensioning system shall yield a v-belt life of 16,000 hrs of operation.
- F. Belt Guard:
1. The belt drive shall be guarded in compliance with OSHA regulations.
 2. Portions of the guard shall be easily removable allowing for belt inspection and replacement.
 3. Guard material shall be perforated galvanized carbon steel.
- G. Gear Drive (if applicable):
1. The blower shall be driven by direct coupled gear driven system.
 2. A robust slip-free gear drive system, which requires no additional oil chambers, oil pumps, or additional bearings shall be utilized.
 3. Drive gears shall be integrated into blower drive side oil chamber.
 4. No additional oil pump, oil reservoir, or heat exchangers shall be used.
 5. Drive motor with flanged direct mount face. Drive motor shall use grease-filled bearings.
 6. Heavy duty mechanical blower/drive shaft seal with drain system towards motor face.
 7. Low radial loads of the motors ball bearing design for long bearing lifetime.
- H. Vibration Isolators:
1. Each package shall be supplied with vibration isolating feet with a minimum efficiency of 80%.
 2. The manufacturer shall be responsible for attenuating noise and vibration in the package such that no special installation base shall be required, nor shall any additional measures be required to reduce vibrations from the package being transmitted to the base or the piping.
- I. Pressure Safety Valve:
1. Each package shall be supplied with a single pressure safety valve on the discharge side of the blower mounted downstream of the discharge silencer and upstream of the check valve.
 2. The safety valve shall be set to protect the machine from exceeding its maximum pressure rating and shall be sized to pass 100% of the design flow.
 3. The valve shall be field adjustable, spring loaded, and have a certificate of conformity to PED if operating above 15 psig.
 4. The pressure safety valve shall be housed inside and exhaust shall be vented out of the sound enclosure. The safety valve shall relieve hot air into a segmented and sealed section of the sound enclosure so that the hot air cannot reenter the inlet of the machine. Weighted relief valves inside the enclosure shall not be permitted. Diaphragm electronically actuated relief valves shall not be permitted.

5. The valve shall be manufactured by Kunkle or approved equal.

J. Check Valve:

1. Each package shall be supplied with one check valve that shall be installed on the discharge line.
2. The check valve shall be of the full-bore low pressure-drop, flapper type design with a steel body, and steel flap embedded in EPDM with full-contact seal.
3. Pressure losses produced by the check valve shall be included in the entire package performance calculation.
4. The check valve shall be provided by the blower manufacturer or approved equal.

K. Special Tools (if applicable)

1. One (1) set of special tools shall be provided for complete service and maintenance of the blowers.

2.4 VARIABLE FREQUENCY DRIVE

A. Each blower package shall include a factory mounted, 6-pulse, constant torque, variable frequency drive.

B. Drive shall operate on 460 VAC, 3 phase, 60 hertz power and shall be integrated with the local blower permissive switches.

C. The drive shall include the following features and accessories:

1. The contractor shall furnish, install and commission separate Blower Control Panels (MCP-800B for blower 1-4) and (MCP-850B for blowers 5-7) for VFDs/ motor starters as outlined. Refer to electrical drawings for panel location and mounting requirements. The enclosure shall be NEMA 4X SS for exterior locations and NEMA 4 for interior locations. The motor control panel shall include but limited to: VFDs / motor starters as outlined, power supply, main 3 phase disconnect C/W front door handle, breakers, fuses, line reactors, terminals, etc. Provide adequate panel heating/cooling to meet panel interior components environmental requirements. All VFDs shall communicate with Remote PLC Panel via Ethernet. Each VFD shall have a front door mounted HIM module. Each motor (VFD/Motor Starters) shall have a front door mounted HOA with green run indicator light and red fault indicator light. VFD manufacturer shall be AB Powerflex or approved equivalent. The drive will be accepted as equal as long as the equipment supplied with the communication adapter capable of connecting to the communication network via the Ethernet/IP Protocol.

D. Branch wiring for LCP supply power so that each blower/VFD will require a single 460VAC feed.

2.5 CONTROLS

A. Local Operator Stations (MCP-800C for blower 1), (MCP-800D for blower 2), (MCP-800E for blower 3), (MCP-800F for blower 4), (MCP-850C for blower 5), (MCP-850D for blower 6), and (MCP-850E for blower 7).

1. Each package shall be supplied with the following control functions and features:
 - a. Intuitive TFT color touch screen display or touch key controls with LED indications on important functions.

- b. Display, monitoring, alarm, and shutdown of inlet pressure, discharge pressure, discharge temperature, enclosure cooling fan thermal overload, main drive motor thermal overload, oil temperature and oil pressure (if applicable).
 - c. Display run hours.
 - d. Log errors and first out indication
 - e. Track and log maintenance
 - f. E-Stop button mounted on front of blower enclosure.
 - g. Operation of enclosure cooling fan motor starter and oil demister
 - h. Ability to transfer measured values, fault and status messages, as well as remaining times of the service intervals to the customer control system via Modbus RTU or Ethernet IP. Controllers that use non-industrial protocols such as CAN shall not be allowed.
 - i. Permissive control function of customer start and stop signals to a motor controller.
 - j. The local control panel shall be provided with the following digital outputs:
 - 1) Common alarm
 - 2) Common fault
 - 3) Ready to run
 - 4) Transfer of external start/stop command.
 - 5) Status remote
 - 6) Alternatively, these outputs can be obtained using the communication protocol.
 - k. The local control panel shall be provided with the following digital inputs:
 - 1) Remote start/stop
 - 2) Motor controller fault
 - 3) Customer E-stop
 - 4) Alternatively, these inputs can be supplied using the communication protocol.
2. Control Enclosure
 - a. NEMA 12 or UL-508A approved and shall meet or exceed IP52 standards for environmental protection.
 - b. Factory installed, integral to sound enclosure.
 3. Control Supply Power
 - a. 460 VAC, 10 Amp feed with 24 VDC transformer
 4. Monitoring Sensors
 - a. Inlet Pressure Transducer
 - b. Discharge Pressure Transducer
 - c. PT 1,000 Discharge Temperature RTD
 - d. PT 1,000 Oil Temperature RTD
 5. Local control panel shall be mounted on each blower enclosure package and supplied by the blower manufacturer.
 6. Blower Master PLC Panel (MCP-800A for blowers 1-4) and (MCP-850A for blower 5-7).
 - a. The contractor shall furnish, install and commission a Remote PLC Panel (MCP-800A and MCP-850A), refer to electrical drawings for panel location. For exterior installation locations see Specification 409601. For interior installation locations see Specification 409602.
 7. MCP Functionality:
 - a. Blower Sequencing and Fault Handling
 - 1) The integrator shall in the Blower Master Control System manage and coordinate the blower system's response to user defined run conditions.

- 2) MCP shall allow for automatic or manual operation of all manufacturer supplied blowers.
 - 3) The number of packages required to meet system demands shall be determined by the MCP and the addition or subtraction of blowers from service shall be coordinated by the MCP.
 - 4) Blower sequencing methods employed by the MCP shall operate packages in the blower system in such a way so as to comply with blower manufacturer startup and shutdown guidelines as well as adhere to all blower manufacturer recommended safety protocols.
 - 5) Blowers shall be sequenced in a Lead/Lag fashion.
 - a) Blowers shall be prioritized operation in a lead, lag1, lagN fashion in accordance with:
 - i. User defined run sequence or Unit runtime; lower runtime prioritized as Lead
 - 6) Blower's sequencing order shall recalculate upon
 - a) The expiration of a user defined timer or Manual activation by operators
 - 7) Blower Modulation/Speed Control
 - a) Blower speed/output for each energized blower package shall be set by the Operator via the MCP.
 - 8) Blowers shall have their speed adjusted in conjunction with each other so as to equally share the load relative to each blower's output for the future function as future function.
- b. MCP Communication and Integration
- 1) MCP shall land and process Field Instrument and Blower IO signals
 - 2) Communication with SCADA/DCS partners at the facility shall be governed by read/write commands issued by others from and to designated read/write arrays on the MCP.
 - 3) Communication methods, network addressing, and communication arrays shall be proposed by the MCP provider at the time of submittal via a MCP provider generated communication coordination sheet and approved/validated by engineer/network administrator with the rest of the technical submittal.
 - 4) IP addresses and networking details shall be proposed and clarified
 - 5) IO points shall be arranged in Arrays (REAL and/or DINT)
 - 6) Read Arrays shall include all field device signals landed at the MCP, as well as running, % output/speed, and fault conditions of each blower controlled.
 - 7) Write Arrays shall provide a means by which a SCADA/DCS partner may be able to relay process specific control data to the MCP (if required)
 - 8) Any additional programming required at the SCADA/DCS to enable reading/writing from/to these communication arrays shall be provided by others.
 - 9) Approved communication methods and parameters shall be factory programmed and verified prior to field commissioning.

B. The integrator shall incorporate the required sensors and alarms onto the SCADA System via Ethernet connection.

C. Each blower shall receive its initial oil filling at the factory. Oil to be fully synthetic and rated for a minimum of 6,000 hours of operation between change intervals.

2.6 ACUSTICAL SOUND ENCLOSURE

- A. Each package shall be supplied with a sound enclosure covering the entire blower package.
- B. The enclosure shall provide suitable protection for outdoor installation under wind loads of 50mph and snow loads of 25lbs/ft².
- C. The enclosure shall be designed so as to be able to install them side-by-side with all maintenance done from the front or back of the package.
- D. Details shall be as follows:
 - 1. Enclosure Panels shall be made of galvanized steel sheet, powder coated, and painted per blower manufacturer standard color. The skid shall be of the same color.
 - 2. Panels and base paint finish shall be pretreated by de-greasing and phosphate cleaning, then powder coated to a thickness of 70 µm -100 µm on both sides.
 - 3. The enclosure and the blower package shall have an oil-drip pan mounted on a skid or the base frame on the sound enclosure shall be designed to collect dripping oil for meeting environment protection standards and for easy transportation and installation (if applicable).
 - 4. A grounding strap shall be installed between the blower base and the package skid to bypass any vibration isolating mounts for grounding continuity.
 - 5. Quick release panels, each less than 50 lb (as mandated by MSHA) must provide easy and quick access for routine maintenance of the blower and the package components.
 - 6. Enclosure Cooling / Ventilation Fan:
 - a. Ventilation fan shall be provided for cooling the sound enclosure.
 - b. The fan shall be sized for sufficient heat removal from the sound enclosure, even when the blower is operated with a VFD.
 - c. The cooling fan shall be driven separately by a 460V, 3Ph, 60Hz electric motor powered by the same 460 VAC electric feed as the local control panel. A 120V single phase motor for this application will not be acceptable as the current draw and motor operating temperature are too high.
 - d. The enclosure cooling fan shall be a dedicated device. The use of the TEFC drive motor to cool the blower or circulate the sound enclosure shall not be allowed.
 - e. To prevent possible operator damage, electrical components, instrumentation, and instrument connections shall be mounted the way it does not interface with moving panels of the sound enclosure.
 - f. Both blower oil sumps shall be piped to a common fill and drain, located at the front of the package for easy maintenance. An oil level indicator shall be mounted on the outside of the enclosure, which gives an accurate oil level indication while the blower is in operation. All oil lines shall be industrial-quality hydraulic hose and fittings. Alternative for an oil drain from the blower drive-end and gear-end lubricating oil sumps separately piped to the front of the blower base with flexible tubing is allowed. The drive-end and gear-end oil chambers shall not be interconnected. Each oil chamber shall have x1 drive-end and x2 gear-end domed designed sight glasses which will allow visual inspection of oil level and oil condition, viewable from the front of the blower.

2.7 SHOP PAINTING

- A. Painting shall be done per the suppliers' standards and meet the following criteria:

1. Except for machined sealing and machined mounting surfaces, the package shall be painted per blower supplier standards.
 2. Aluminum, stainless steel, and brass shall not be painted.
 3. The supplied motor shall not be over sprayed and shall be supplied with the motor manufacturer's standard protection and paint color.
 4. Painted Cast Iron and Carbon Steel shall be Alkyd Resin Primer and Final coat with a total dry film thickness of 70µm. Surface preparation SSPC10 or better.
 5. Sound enclosure parts are to be powder coated. Panels and base paint finish shall be pretreated by de-greasing and phosphate cleaning, then powder coated to a thickness of 70 µm -100 µm on both sides.
 6. Galvanized components shall only be painted with appropriate surface preparation.
 7. The blower package to be painted the blower manufacturer's standard colors.
- B. Surface preparation, application and minimum DFT millage to be as per the paint manufactures published recommendation.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. The blower system shall be handled and installed in accordance with the manufacturer's recommendations and instructions as shown in the location on the drawings.
- B. Contractor shall field verify all dimensions and elevations. The engineer shall be notified of any specific differences.
- C. The blower system shall arrive on site ready for installation. Aligning, adjusting and filling the blower with lubrication shall not be required by the contractor.
- D. Initial lubrication required for startup and field test operation shall be furnished and applied in accordance with the manufacturer's recommendations.

3.2 INITIAL LUBRICATION

- A. Initial lubrication required for startup and field test operation shall be furnished and applied in accordance with the manufacturer's recommendations.

3.3 INSPECTION, STARTUP AND TESTING

- A. After installation of all equipment has been completed and as soon as conditions permit, the manufacturer shall provide One (2) trip for a total of Five (5) 8-hour days to verify the installation of blowers and conduct an acceptance test under actual operating conditions.
 1. The Manufacturer shall perform a physical check of the blower installation, perform safety checks, power up the equipment and perform functional testing.
 2. The functional test shall consist of 4 hours of operation of each blower with vibration, temperature, and pressure readings as well as motor amp readings taken and recorded at 60-minute intervals.
 3. The Manufacturer shall provide operations and maintenance training to the plant personnel. The training shall consist of 1 hour of classroom training using the Operation

and Maintenance Manual for reference and 2 hours of hands-on training at the blower package.

- B. If required, Contractor shall make any changes, at his own expense, to the installation that may be necessary to assure satisfactory operation. Contractor shall be held liable for changes needed in the installation.
- C. If the blower system does not meet the Specification, corrective measures shall be taken or the package shall be removed and replaced with a package which satisfies the conditions of the Specifications.
- D. Manufacturer shall provide a written field test / start up report after completion of testing.

3.4 LUBRICATION

- A. The equipment shall be lubricated by the Contractor when erected and he shall furnish the necessary oil and or grease for one (1) year of operation. The grades of oil and grease shall be in accordance with the recommendations of the manufacturer.

3.5 OPERATION AND MAINTENANCE MANUALS

- A. Prior to or with the delivery of equipment, the manufacturer shall provide copies of an operation and maintenance manual including storage, installation, start-up, operating and maintenance instructions, and a complete parts list and recommended spare parts list. The O & M Manuals shall be in compliance with the General Requirements.

3.6 SCHEDULE

- A. The blowers shall be as specified or equal and have the following characteristics.

Parameters	Blowers No. 1-4	Blowers No. 5-7
Quantity	4	3
Location	Existing shed at the Sludge Transport / Electrical Building	New Shed Building
Site Conditions	100°F, 971 ft ASL, 90% RH	
Discharge Pressure	7.21 PSIG	7.10 PSIG
Design Blower Capacity	1000 SCFM	1134 SCFM
Minimum Turndown	65%	70%
Blower Max. Speed	7339 RPM	8869 RPM
Operating Conditions:	Continuous	Continuous
Power Supply	480V, 3 Phase, 60Hz	
Max Motor Size	50 HP	50 HP
Drive	VFD	
Noise Level with enclosure	< 80 dB(A) @ 1 meter at design point	

END OF SECTION 431134

PART 1 - SECTION 432110 - PROGRESSING CAVITY PUMPS GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
- B. References
 - 1. AISI American Iron and Steel Institute
 - 2. ASTM American Society for Testing and Materials
 - 3. IEEE Institute of Electrical and Electronic Engineers
 - 4. NEMA National Electrical Manufacturers Association
 - 5. SSPC Steel Structures Painting Council
 - 6. NFPA 70 National Electric Code (NEC)

1.2 SUMMARY

- A. This section includes the furnishings and installation of positive displacement, progressing cavity pumps and all pertinent accessories, complete and in place, ready for service as shown on the Drawings and described in this section. This includes:
 - 1. Two (2) Sludge Transfer Pumps
 - 2. Two (2) Sludge Dewatering Feed Pumps, equipped with VFDs.
- B. The pump shall include all drives, VFDs as applicable, drive shafts, couplings, piggy-bag arrangement with belts and belt guards for the Sludge Transfer pumps and in-line motor arrangement for Dewatering Feed Pumps, drive bases, pump bases, anchor bolts, and other appurtenances as specified or required for a complete installation.
- C. All pumps shall be of the same manufacturer. Equipment Schedule is provided at the end of this section.
- D. The pumping units shall be of the self-priming, positive displacement, progressing cavity type.
- E. Furnish all labor, material, equipment, products, incidentals, and testing required and necessary to provide a complete and operational system. Install where noted on the drawings and as specified within these specifications.
- F. The unit shall include all manufacture's motors, starters/electrical work necessary connecting conduit, wiring controls, control panels within requirements of Division 26. Motor starters shall be provided under Division 26 by the Electrical Contractor.
- G. Coordinate all work with this equipment and any other associated equipment, installed and specified under other sections of these specifications.
- H. The Supplier shall examine the Site conditions, intended application, and operation of the pump system and recommend the pump which will best satisfy the indicated requirements.
- I. All work performed under this section shall be in accordance with all approved trade practices and manufacturer's recommendations.

1.3 QUALITY ASSURANCE

- A. In addition to requirements of these specifications, comply with manufacturer's instructions and recommendations for work.
- B. Provide equipment that is a standard product of the manufacturer.
- C. The pumps, gear reducers, and motors shall be a product of the manufacturers' regularly engaged in the manufacturing of equipment having similar service and equal size for a minimum of ten (10) years and a minimum 20 installations at equivalent applications. Supplier shall provide a list of names and dates of installations for verification by the engineer or Owner's Representative.
- D. Factory test each pump using water with a factory certified motor, the same size as that specified. Tests shall consist of checking each pump at its rated speed, head, capacity, efficiency, and brake horsepower; and at such other conditions of head and capacity to properly establish the performance curve. Submit copies of the performance curves to the Contractor for Engineer review prior to releasing the pumps to the Contractor. The standards of the Hydraulic Institute shall govern the procedures and calculations for these tests.
- E. All pumping equipment furnished under this Section shall be of a design and manufacture that has been used in similar applications and it shall be demonstrated to the satisfaction of the Owner that the quality is equal to equipment made by that manufacturer specifically named herein.

1.4 SUBMITTALS

- A. General: Submit the following in accordance with conditions of Contract and Division 1 Specification Sections.
- B. Product Data: Submit the manufacturer's technical data and installation instructions including certified pump curves with efficiency, capacity, head, speed, brake horsepower required and operating point required for each pump.
- C. Shop Drawings: Submit the manufacturer's technical data and installation instructions including certified pump curves with efficiency, capacity, head, speed, brake horsepower required and operating point required for each pump.
 - 1. Complete description in sufficient detail to permit an item-by-item comparison with the Specification. Complete description in sufficient detail to permit an item-by-item comparison with the Specification,
 - 2. Dimensions and required clearances,
 - 3. Pump with motor weights
 - 4. Performance data including pump curves showing overall pump efficiencies, low rate, head, break horsepower, motor horsepower, speed and shut-off head.
 - 5. Materials of construction
 - 6. Layout drawings for all equipment showing installation details and anchor bolt layout.
 - 7. Wiring diagrams for all electrical equipment.
 - 8. Deviations from Contract Documents.

9. Manufacturer's installation and testing instruction.
10. Manufacturer's standard guarantee.
11. Certification from the pump supplier that site conditions have been examined.

D. Maintenance and Operating Instructions, including the following additional information:

1. Recommendations for short and long term storage.
2. Explanation of operating safety considerations.
3. Detailed installation instructions, with clear step-by-step points on the correct mechanical and electrical installation procedures.
4. Repair parts and maintenance materials.
5. Troubleshooting data.
6. Repair data.
7. Manufacturer's warranty.

1.5 DELIVERY, STORAGE AND HANDLING

A. All equipment shall be delivered in the largest pieces practical for field assembly by the Contractor. Individual pieces shall be permanently tagged with welded erection marks or stainless steel tags cross referenced with information on the manufacturer's erection and assembly drawings.

B. Packing, Shipping, Handling and Unloading.

1. Comply with Section 016600, Product Handling and Protection.

C. Acceptance at Site.

1. Inspect all equipment and materials against reviewed Shop Drawings at time of delivery.
2. Equipment and materials damaged or not meeting the requirements of the reviewed Shop Drawings shall be immediately returned for replacement or repair.

D. Storage and Protection

1. Carefully prepare for storage and label all equipment and materials after they have been inspected.
2. Store all equipment and materials in a dry, covered, ventilated location and protect from harm according to the manufacturer's instructions.

1.6 SEQUENCING

A. Do not install equipment until design strength of all cast-in-place concrete supporting elements has been attained and all supporting steel has been adequately bolted, braced, and welded.

B. Comply with Section 011100 Summary of Work.

1.7 WARRANTY

A. The pump manufacturer shall guarantee the complete pumping assemblies for a period of 12 months after acceptance or 18 months after shipment, whichever occurs first. The warranty as specified here shall cover all defective parts, material, and workmanship.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Subject to compliance with specified requirements, supply the progressing cavity pumps from one of the following manufacturers:
1. Moyno Pumps.
 2. Netzsch Pumps.
 3. Or Engineer Approved equal.
- B. Contractor choosing an alternative shall refer to the Bid Form. Any proposed alternative must provide all of the qualities described within this specification along with the bid.

2.2 PUMP CONSTRUCTION

- A. General:
1. The pumps shall be heavy duty, positive displacement, single stage, progressing cavity type. The pumps shall be cradle mounted to allow the normally vertical suction port to be rotated to any angle perpendicular to the centerline to facilitate piping connections.
 2. Full service in place (FSIP) design shall be provided, if available, to allow the replacement of the rotor and stator without having to disconnect the pump from the suction or discharge piping.
- B. Pump Suction and Discharge Casing
1. The pump casing shall be designed for the type of service specified and shall be of sufficient strength, weight, and metal thickness to ensure long life, accurate alignment, and reliable operation.
 2. The suction and discharge connections shall be ANSI/B16.1 flanges sized for the pump specified. The discharge flange shall have a vent/gauge connection that can be rotated in 90 increments. The discharge support feet shall be separate from the discharge flange.
 3. Two (2) square hand-hole side plates on each side of the pump, 180° apart, large enough to permit easy inspection of the drive shaft joint and mechanical seal and servicing of pump.
 4. The casing shall have multiple 3/4-inch FNPT connections (minimum 4) for vents, drains, and gauges. The connections shall be at the highest and lowest point of the housing regardless of suction orientation.
 5. There shall be a top inspection cover integral to the design to allow for inspection of rotor joint and clean out of the suction body.
- C. Stator
1. Stators shall be of double helix design and chemically bonded to the inside of a carbon steel tube. Stators formed from a single piece carbon steel casing are also acceptable. Additional hardware to seal around the stator shall not be accepted. Split stators or stators with sealing lines are not acceptable as the can potentially leak.
 2. The Shore A durometer of the BUNA stator shall be 71+4.
 3. The stator shall be machined with grooves to accept a 720° retaining ring. The stator affixed to the suction casing by the use of four (4) tie-bar bolts for easy removal replacements are also acceptable.

4. The stator shall be fastened to the suction housing and discharge flange with removable clamp rings to facilitate stator removal. The stator affixed to the suction casing by the use of four (4) tie-bar bolts for easy removal replacements are also acceptable.

D. Rotor:

1. The rotor shall be precision machined from tool steel with a chromium content of 11-13.5% hardened to a Rockwell C hardness of C57-60 and then covered with heavy layers of hard chrome plating.
2. The removal of the rotor shall not require any disconnection of the suction or discharge piping. Pump shall be full service in place, if available. Deviations or special adaptors are not allowed.

E. Joints

1. Gear joints shall be of the grease lubricated crowned gear type, totally enclosed and protected by a wire reinforced elastomeric seal. Oil filled gear joints with double seals are also acceptable.
2. Mechanical components of the gear joints shall be designed to operate for 10,000 hours at the manufacturer's published maximum speeds and pressures.
3. Universal type of joints: The rotor shall be connected to the drive shaft by means of a connecting rod with high strength, shock resistant universal gear joints. Pin joints are not acceptable.
4. The sealed gear type universal joints shall be lubricated by oil or grease.

F. Drive Train

1. The rotor shall be drive by means of a heavy-duty drive train. The rotor shall be joined to the drive shaft by means of a connecting rod with gear joints.

G. Shaft Seal

1. Mechanical seals shall have a type 316 stainless steel springs with knife edged Silicon carbide rotating face, Silicon carbide stationary face, and Viton bellows. Mechanical seals that have exposed spring designs are not acceptable for risk of allowing solids to be trapped in the springs. Flat rotating face designs are not acceptable for risk of putting more stress on the seal faces at pump start-up and the increased risk of overheating.
2. The mechanical seal shall be inside mounted, located inside the pump suction housing with ample open area around the seal and not in a dead-end enclosed housing where solids could accumulate.
3. The shaft seal shall not be more than 2 inches perpendicular away from the suction port to ensure proper seal flushing and cooling around the seal faces. Seals sitting inside a stuffing box shall not be accepted.

H. Pump Drive Shaft

1. The drive shaft shall be of the solid drive shaft design in order to avoid clogging and/or trapping of solids, which could either interrupt the movement of the connecting rod or disturb the seal of the rear gear joint. Maximum shaft deflection under normal operating conditions shall not exceed 0.002-inch.
2. The universal joint head shall be removable from the drive shaft to allow access to the stuffing box or mechanical seal without disturbing the drive end of the pump.

I. Motor mounted in a piggy-bag arrangement with belts and guards (Sludge Transfer Pump):

1. Motor shall be of sufficient size so that there will be no overload on the motor above rated nameplate horsepower under any condition of operation from shut-off to zero head, unless otherwise specifically permitted in this Section.
2. Motor Enclosure Type: TEFC
3. Motors shall be suitable for use on adjustable frequency drives.

J. Belt Drive:

1. Belt drives shall be either V-belt or cogged timing belt. V-belt and sheave groove dimensional tolerances shall be in accordance with the "Engineering Standards – Multiple V-Belt Drives" published by the Multiple V-Belt Drive and Mechanical Power Transmission Association. Belt drives shall have a service factor of at least 1.6 at maximum speed based on the nameplate power rating of the drive motor. The speed reduction ratio of belt drives shall not exceed 5 to 1. Sufficient clearance shall be provided for access to the stuffing box. Each belt drive shall include a sliding base or other suitable means of tension adjustment. Belt drives shall be the piggy-back type.

K. Gear Motor (Dewatering Feed Pump):

1. Manufacturer: NORD or equal.
2. Gear motors or gear reducers shall be designed in accordance with AGMA 6019-E (Class II).
3. Unless otherwise noted, gear motors shall:
 - a. Be Energy efficient.
 - b. Have TEFC enclosure.
 - c. Be heavy and inverter duty rated, suitable for 460-volt, 3 phase, 60 Hz power supply.
 - d. Have Class F insulation.
 - e. Be integral to the gear reducer.
 - f. Be suitable for a 5:1 constant torque turndown ratio
 - g. Conform to the provisions of National Electric Code.
4. The gear reducer shall be in-line with a 1.4 service factor. The gear case is to be single piece SAE 30 gray cast iron with internal reinforcements for strength rigidity.
5. The nominal input power rating of each gear or speed reducer shall be at least equal to the nameplate power rating of the drive motor. Drive units shall be designed for 24-hour continuous service.
6. The gearbox drive shaft shall be solid mounted in two ball or tapered roller bearings oil lubricated. Gearbox shall have the ability to be removed without requiring any pump disassembly.
7. The gear box or gearmotor shall be in compliant with the Anti-Friction Bearing Manufacturer's Association Minimum B-10 life expectancy of the bearings and be in excess of 100,000 hours at the maximum operating conditions of this Specification.
8. The thermal power rating of each unit shall equal or exceed the nameplate power rating of the drive motor. During continuous operation, the maximum sump oil temperature shall not rise more than 100°F above the ambient air temperature in the vicinity of the unit and shall not exceed 200°F.
9. Each gear reducer shall be a totally enclosed unit with oil lubrication and antifriction bearings throughout.
10. Furnish a flexible, forged steel coupling of an approved type for connecting the pump and motor.
 - a. Coupling shall be of the proper size to transmit the power required to drive the pump under all conditions of operation.

- b. Coupling shall be suitably lubricated and designed for long periods of continuous operation.
- c. Coupling design shall take care of inaccuracies of alignment and permit axial adjustment.
- d. Coupling construction shall be such that shaft of a unit may be removed without disturbing adjustment of the other.
- e. Provide and install an approved steel guard over the coupling.

2.3 ACCESSORIES

A. Pump dry-run protection

- 1. The pump shall have a thermal probe attached to the stator to monitor stator temperature.
- 2. The probe shall be connected to a control that would trigger a switch to activate an alarm and/or to shut the pump down to prevent dry run (not ruin the stator). The pump safety control instruments shall be provided by the pump manufacturer and installed in the Control Panel by the Control Integrator.

B. Over Pressure Protection: Each pump unit shall be supplied with a silicone-filled isolation ring with a dual mounted gauge and single point pressure switch. The pressure ranges for the switch and gauge shall be selected specifically for each specified service. The isolation ring shall be mounted between ANSI flanges, be sized according to the discharge pipe as shown on the plans and be constructed with a carbon steel body and fittings with a Buna sleeve.

- 1. A discharge pressure gauge and pressure switch shall be furnished by the pump manufacturer for each pump. The pressure shall read in pounds per square inch. The range of each pressure transmitter shall be 0-200 psig.
- 2. The pressure switch and gauge shall be protected by a radial gauge isolator capable of covering the full pressure range. Flat diaphragm isolators are not acceptable.
- 3. The switch shall be SPDT, NEMA 4.

C. Suction side pressure gauges:

- 1. Pump suction flanges shall be tapped for gauge connection.
- 2. Gauge connection shall be 3/4-inch diameter.
- 3. Each connection shall include a shutoff needle valve and necessary length of pipe to allow the mounting of a pressure gauge. The open end of the gauge connection shall be plugged to prevent the accumulation of debris.
- 4. Each pump shall be supplied with liquid filled pressure gauge(s) with snubber and diaphragm seal. Liquid shall be glycerin-water mixture. Suction gauge shall be adequately sized to indicate suction conditions. The gauges shall be properly installed on the pump suction and discharge lines.
- 5. On suction side, the gauges shall operate over a range of 20 inches of mercury vacuum to 10 psig pressure.
- 6. Manufacturer: Gauges shall be a product of H.O. Trerice, Ashcroft, Wika or equal.

D. The Contractor shall provide expansion joints for pump suction and discharge lines. Flexible Expansion Pump Connectors: Expansion joints shall be a rubber spool type of a single, open wide arch design. Joint construction shall consist of a Butyl tube and cover, reinforced with a suitable woven fabric. Joints shall be designed to meet the design pressures and temperature for the system. Expansion joints ends shall be flanges drilled to 150 lbs class

standards, and be full rubber faced and integral to the body. Flange backing rings of cast iron with a built-in support sleeve shall be provided. Expansion joints shall be Flexicraft Industries, Flextra 150 Model, or equal.

- E. Data Plates: Attach stainless steel data plates to the pump, showing the manufacturer's name, pump size and type, serial number, capacity and head rating, and other pertinent data. Attach a special data plate to the pump frame listing identification of the frame and bearing numbers.
- F. Hardware: All machine bolts, nuts and cap screws shall be hex head. Hardware or parts requiring special tools or wrenches shall not be used.

2.4 CONTROLS

A. Sludge Transfer Pumps

1. The contractor shall furnish, install and commission a Remote PLC Panel (MCP-950A), refer to electrical drawings for panel location. For exterior installation locations see Specification 409601. For interior installation locations see Specification 409602.
2. The contractor shall furnish, install and commission a separate Motor Control Panel (MCP-950B) for VFDs/ motor starters as outlined. Refer to electrical drawings for panel location and mounting requirements. The enclosure shall be NEMA 4X SS for exterior locations and NEMA 4 for interior locations. The motor control panel shall include but limited to: VFDs / motor starters as outlined, power supply, main 3-phase disconnect C/W front door handle, breakers, fuses, line reactors, terminals, etc. Provide adequate panel heating/cooling to meet panel interior components environmental requirements. All VFDs shall communicate with Remote PLC Panel via Ethernet. Each VFD shall have a front door mounted HIM module. Each motor (VFD/Motor Starters) shall have a front door mounted HOA with green run indicator light and red fault indicator light. VFD manufacturer shall be AB Powerflex or approved equivalent.

B. Sludge Dewatering Feed Pump Grinder

1. The contractor shall furnish, install and commission a Remote PLC Panel (MCP-1000A), refer to electrical drawings for panel location. For exterior installation locations see Specification 409601. For interior installation locations see Specification 409602.
2. The contractor shall furnish, install and commission a separate Motor Control Panel (MCP-1000B) for VFDs/motor starters as outlined. Refer to electrical drawings for panel location and mounting requirements. The enclosure shall be NEMA 4X SS for exterior locations and NEMA 4 for interior locations.
3. The motor control panel shall include but limited to: VFDs / motor starters as outlined, power supply, main 3-phase disconnect C/W front door handle, breakers, fuses, line reactors, terminals, etc. Provide adequate panel heating/cooling to meet panel interior components environmental requirements. All VFDs shall communicate with Remote PLC Panel via Ethernet. Each VFD shall have a front door mounted HIM module. Each motor (VFD/Motor Starters) shall have a front door mounted HOA with green run indicator light and red fault indicator light. VFD manufacturer shall be AB Powerflex or approved equivalent.
4. All respective system field mounted devices and instrumentation shall be wired to the (MCP-1000A/B) for a complete operating system as shown on the Drawings and as specified herein.

- C. Each pump shall be provided with easily identifiable terminal points to facilitate the exchange of the central control functions between the pumps and the process control system as indicated on the Contract Drawings
- D. Sludge Transfer Pumps' control shall consist of following:
1. Local Control Panel shall be equipped with Remote/Local modes of operation.
 2. SCADA system shall have Manual/Auto selector switches that shall allow running sludge transfer pump from the SCADA panel in Auto and Manual mode. In the Manual mode, the sludge transfer operation shall be run only from the Local Control Panel.
 - a. Auto mode of operation is based on choosing flow path either for Grinder #1 and Pump #1; or Grinder #2 and Pump #2 with respect to the motor operated valves on the pump suction and discharge side in the "Open" position.
 - b. Interlocks are present between Motor Operated Valves and the respective Grinder-Pump operation.
 3. Local mode of operation shall allow operator to select motor operated valves - Grinder #1/2 and Pump #1/2. In the Local mode each motor operated valve, Grinder, and Pump will be started manually.
 4. Alarms
 - a. Pump running dry.
 - b. Over pressure.
 - c. Motor overload
 - d. If Grinder stops running, it shall stop the Pump operation and annunciate an Alarm.
 - e. If Pump stops running, it shall stop the Grinder and annunciate an Alarm.
- E. Sludge Dewatering Feed Pumps
1. IP Flowmeter value from Screw Press Control Panel displayed locally.
 2. Local Control Panel shall be equipped with Auto/Manual/Hand modes selector switch.
 3. Interlocks: Grinder #1, Pump #1 and Screw Press; or Grinder #2, Pump #2 and Screw Press.
 4. When selector switch is set to Auto at the Grinder-Pump Local Control Panel, it enables the Grinder-Pump- and Screw Press to run together in the Automatic mode of operation from the Screw Press HMI Screen or SCADA. The flowmeter controller located in the Sludge Dewatering Building on the Dewatering Feed Pump force main to the Screw Press will control the VFDs on the feed pumps.
- Note, there are only manual valves installed on the pump suction and discharge piping. The flow path shall be set by opening corresponding valves on the suction and discharge piping prior to Grinder-Pump starting.
5. In "Manual" mode, the Grinder, Pump and Screw Press will be started manually from the HMI or SCADA.
 6. The "Hand" mode of operation is mainly for the equipment maintenance, it causes the Grinder - Pump run only from the Local Control Panel.
 7. Dewatering Feed Pump VFDs are included in the Pump Control Panel.
 8. Alarms
 - a. If Grinder or Pump stops running, it triggers an Alarm and shut down the Screw Press.
 - b. If Screw Press stops running, it shall stop the respective Grinder and Pump operation.
 - c. Pump Alarms
 - 1) Pump running dry.

- 2) Over pressure.
- 3) Motor overload.
- 4) If Grinder stops running it shall stop the Pump operation and annunciate an Alarm.
- 5) If Pump stops running it shall stop the Grinder and annunciate an Alarm.

2.5 SPARE PARTS AND SPECIAL TOOLS

A. Spare parts to be provided for each set of pumps supplied:

1. One (1) complete mechanical seal
2. One (1) one rotor
3. One (1) stator
4. One (1) connecting rod assembly.
5. One (1) joint kit
6. One (1) set V-belts, where applicable.
7. One (1) complete set of any special tools required to dismantle pump.

2.6 SURFACE PREPARATION AND PAINTING

A. Shop Finishing

1. Protect all exposed ferrous metals with a minimum of one coat of shop primer. Apply an additional coat of two-part epoxy to motors, pumps, gear boxes, and other similar equipment.
2. All surfaces must be dry, clean, and free of rust, scale, oil and grease. Clean steel surfaces by pickling or blasting to a minimum of SSPC-SP6.
3. Surface preparation, application and minimum DFT millage to be as per the paint manufactures published recommendation.
4. **Painting shall be in accordance with the manufacturer standards.**

B. Field Painting

1. All rust, scale, dirt or other foreign matter shall be removed by solvent cleaning, wire brushing, short blasting or other standard commercial cleaning procedure.
2. Grinders shall be field painted and finish coated in accordance with the Owner's Color Coding and Process System Identification color with the standard commercial finish per Specification Section 099700 Special Coating.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install equipment and accessories in accordance with reviewed Shop Drawings and manufacturer's instructions, as specified herein and shown on Contract Drawings.
- B. Furnish and set stainless steel anchor bolts with nuts and washers in accordance with the manufacturer's recommendations.
- C. All electrical equipment, conduit and wiring not indicated on the Drawings, but necessary to provide a complete operating system shall be provided at no additional cost to the Owner.

- D. Electrical Wiring: The external conduit and wiring required for power supply and control to electrical equipment supplied in this Section shall be furnished and installed in Division - 16, Electrical.
- E. Motor size: Any deviation in motor size must be approved by the Engineer. Any electrical equipment or wiring that must change to accommodate a different size motor will be at no additional cost to the Owner.
- F. The grade and amount of oil and grease shall be in accordance with the manufacturer's recommendations.
- G. Initial lubrication required for startup and field test operation shall be furnished and applied in accordance with the manufacturer's recommendations.

3.2 FIELD QUALITY CONTROL

- A. The manufacturer shall furnish the services of a qualified representative for a period of not less than one day to inspect and adjust the equipment furnished in this section. This qualified representative shall also conduct such tests as necessary to demonstrate satisfactory operation and to instruct the Owner's personnel in the care and operation of the equipment.
- B. The service representative of the Manufacture shall be present at the site for two (2) work-days, to furnish the startup services and training of the Owner's personnel covering the operation, mechanical maintenance and electrical requirements. If additional service is required due to the mechanisms not being fully operational, at the time of service requested by the contractor, the additional service days will be at the contractor's expense.
- C. For the purposes of this section, a work-day is defined as an eight hour period at the Site, excluding travel time.

3.3 TESTING

- A. After completion of installation, the pumps shall be completely tested to demonstrate compliance with operating requirements as specified.

3.4 MAINTENANCE

- A. Comply with the requirements of Section 017823
- B. Repair Parts and Maintenance Material:
 - 1. Supply tools and a repair parts kit for the grinder furnished as recommended by the manufacturer.

3.5 FULL SERVICE IN PLACE

- A. Manufacturer shall provide pumps with the full service in place (FSIP) design, if applicable, which allows to replace the rotor and stator without having to disconnect the pump from the suction or discharge piping.

- B. Full service in place (FSIP) design shall be provided to allow the replacement of the rotor and stator without having to disconnect the pump from the suction or discharge piping.

3.6 PUMP SCHEDULE

A. SLUDGE TRANSFER PUMPS

1.	Location	-	Basement of Sludge Transfer Building
2.	Service	-	Aerobically digested Waste Activated Sludge from Sludge Holding Tanks 1-3 to Sludge Wet Well
3.	Percent of Solids	-	2% to 6%
4.	Quantity	-	2
5.	Number of stages	-	1
6.	Design flow capacity	-	300 gpm
7.	Design flow pump head	-	66 ft (29 psi)
8.	Maximum pump speed	-	266 RPM
9.	Minimum motor size	-	15 Hp
10.	Motor Max Speed:	-	1750 RPM
11.	Suction Lift	-	20 ft
12.	Duty	-	Constant
13.	Drive	-	Constant speed
14.	Ambient environment	-	Indoors
15.	Fluid service	-	Aerobically Digested waste activated sludge
16.	Fluid temperature	-	Ambient
17.	Type of suction port	-	Flanged
18.	Suction and Discharge:	-	8" 125 # FF ANSI per ASME 16.5B
19.	Maximum pump length	-	6'-6" including space required for disassembly

B. SLUDGE DEWATERING FEED PUMPS

1.	Location	-	Sludge Transport / Electrical Building
2.	Service	-	Sludge feed from the Sludge Wet Well to Dewatering Equipment
3.	Fluid service	-	Aerobically Digested waste activated sludge.
4.	Percent of Solids	-	2% to 6%
5.	Quantity	-	2
6.	Number of stages	-	1
7.	Design flow capacity	-	180 gpm
8.	Design flow pump head	-	52 ft (22.51 psi)
9.	Maximum pump speed	-	281 RPM
10.	Suction Lift	-	20 ft
11.	Duty	-	Constant
12.	Minimum motor size	-	10 Hp
13.	Motor Speed	-	1750 RPM
14.	Drive	-	VFD
15.	Ambient environment	-	Indoors
16.	Fluid temperature	-	Ambient
17.	Type of suction port	-	Flanged
18.	Suction and Discharge:	-	8" 125 # FF ANSI per ASME 16.5B

END OF SECTION 432110

SECTION 432513 - SUBMERSIBLE PUMPS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and all Specification Sections, apply to work of this section.
- B. References:
 - 1. HIC Hydraulic Institute Test Code
 - 2. ASTM A48 Specification for Gray Iron Castings
 - 3. ASTM A108 Specification for Steel Bars, Carbon, Cold-Finished, Standard Quality
 - 4. ASTM A276 Specification for Stainless Steel Bars and Shapes
 - 5. ASTM A36 Specification for Carbon Structural Steel
 - 6. ASTM B62 Specification for Composition Bronze or Ounce Metal Castings
 - 7. ASTM A743 Specification for Castings, Iron-Chromium, Iron-Chromium-Nickel, Corrosion Resistant, for General Application / ASTM A744
 - 8. ANSI American National Standards Institute
 - 9. AWWA American Water Works Association
 - 10. FM Factory Mutual
 - 11. IEEE Institute of Electrical & Electronic Engineers
 - 12. NEC National Electrical Code
 - 13. NEMA National Electrical Manufacturers Association
 - 14. UL Underwriters' Laboratories Incorporated
 - 15. Ohio BC International Building Code

1.2 DESCRIPTION OF WORK

- A. This specification includes non-clog submersible pumps for the Raw Influent Pump Station, Tertiary Filter Pump Station, RAS/WAS Pump Station, and Aerobic Digesters No. 4 & 5.
 - 1. Raw Influent Pump Station:
 - a. The contractor shall furnish, install and commission a Remote PLC Panel (MCP-100A), refer to electrical drawings for panel location. For exterior installation locations see Specification 409601. For interior installation locations see Specification 409602.
 - b. The contractor shall furnish, install and commission a separate Motor Control Panel (MCP-100B) for VFDs/ motor starters as outlined. Refer to electrical drawings for panel location and mounting requirements. The enclosure shall be NEMA 4X SS for exterior locations and NEMA 4 for interior locations. The motor control panel shall include but limited to: VFDs / motor starters as outlined, power supply, main 3 phase disconnect C/W front door handle, breakers, fuses, line reactors, terminals, etc. Provide adequate panel heating/cooling to meet panel interior components environmental requirements. All VFDs shall communicate with Remote PLC Panel via Ethernet. Each VFD shall have a front door mounted HIM module. Each motor (VFD/Motor Starters) shall have a front door mounted HOA with green run

indicator light and red fault indicator light. VFD manufacturer shall be AB Powerflex or approved equivalent. All respective system field mounted devices and instrumentation shall be wired to the (MCP-100A/B) for a complete operating system as shown on the Drawings and as specified herein.

2. The Contractor shall furnish and install a total of four (4) explosion proof, submersible, solids handling pumps. These pumps shall be installed in the existing wet well, replacing the three (3) existing pumps and installing the fourth pump as shown on the Drawings. Contractor shall provide all necessary accessories, including guide rails, discharge base and base elbow, discharge piping and supports, lifting chain with hooks, discharge base and base elbow, discharge piping, all necessary fittings, and new valves, VFDs and power supply, radar type level sensor, HH-LL alarm floats, control panel for a complete operating system as shown on the Drawings and as specified herein.
3. Contractor shall provide temporary bypassing during construction activities. Each pump shall be capable of handling raw, unscreened domestic sewage consisting of water, fibrous materials, and up to 3-inch diameter spherical solids.

B. Tertiary Filter Pump Station:

1. The contractor shall furnish, install and commission a Remote PLC Panel (MCP-650A), refer to electrical drawings for panel location. For exterior installation locations see Specification 409601. For interior installation locations see Specification 409602.
2. The contractor shall furnish, install and commission a separate Motor Control Panel (MCP-650B) for VFDs/ motor starters as outlined. Refer to electrical drawings for panel location and mounting requirements. The enclosure shall be NEMA 4X SS for exterior locations and NEMA 4 for interior locations. The motor control panel shall include but limited to: VFDs / motor starters as outlined, power supply, main 3-phase disconnect C/W front door handle, breakers, fuses, line reactors, terminals, etc. Provide adequate panel heating/cooling to meet panel interior components environmental requirements. All VFDs shall communicate with Remote PLC Panel via Ethernet. Each VFD shall have a front door mounted HIM module. Each motor (VFD/Motor Starters) shall have a front door mounted HOA with green run indicator light and red fault indicator light. VFD manufacturer shall be AB Powerflex or approved equivalent.
3. All respective system field mounted devices and instrumentation shall be wired to the (MCP-650A/B) for a complete operating system as shown on the Drawings and as specified herein.
4. Contractor shall furnish and install a total of three (3) submersible pumps for transferring flow from Tertiary Filters to Post Aeration. These pumps shall be installed into the new Tertiary Filter Pump Station wet well and consist of pump, discharge piping, valves and fittings, guide rails and supports, lifting chain with hooks, access hatches, vents, motor, ultrasonic level sensor, VFDs and power supply, HH-LL alarm floats, control panel for a complete operating system as shown on the drawings and as specified herein.
5. A valve vault shall be constructed to contain the check and plug valves as shown on the Drawings. These pumps shall be designed for the clean-water operation.

C. RAS/WAS Pump Station:

1. The contractor shall furnish, install and commission a Remote PLC Panel (MCP-350A), refer to electrical drawings for panel location. For exterior installation locations see Specification 409601. For interior installation locations see Specification 409602.
2. The contractor shall furnish, install and commission a separate Motor Control Panel (MCP-350B) for VFDs/motor starters as outlined. Refer to electrical drawings for panel location and mounting requirements. The enclosure shall be NEMA 4X SS for exterior locations and NEMA 4 for interior locations. The motor control panel shall include but limited to: VFDs / motor starters as outlined, power supply, main 3 phase disconnect C/W front door handle, breakers, fuses, line reactors, terminals, etc. Provide adequate panel heating/cooling to meet panel interior components environmental requirements. All VFDs shall communicate with Remote PLC Panel via Ethernet. Each VFD shall have a front door mounted HIM module. Each motor (VFD/Motor Starters) shall have a front door mounted HOA with green run indicator light and red fault indicator light.
3. VFD manufacturer shall be AB Powerflex or approved equivalent.
4. All respective system field mounted devices and instrumentation shall be wired to the (MCP-350A/B) for a complete operating system as shown on the Drawings and as specified herein.
5. The Contractor shall furnish and install a total of two (2) explosion proof, submersible solids handling pumps for pumping return activated (RAS) solids and waste activated solids (WAS). These pumps shall be installed in the existing RAS/WAS Pump station in place of the existing pumps.
6. Contractor shall provide all necessary accessories, including guide rails, discharge base and base elbow, discharge piping, necessary fittings, and the new valves, VFDs and power supply, radar level sensor, HH-LL alarm floats, control panel for a complete operating pumping system in accordance with the following specification and as shown on the Drawings.
7. Contractor shall provide temporary bypassing during construction activities. Each pump shall be capable of handling raw, unscreened domestic sewage consisting of water, fibrous materials, and up to 3-inch diameter spherical solids.

D. Aerobic Digesters No. 4 and 5:

1. The contractor shall furnish, install and commission a Remote PLC Panel (MCP-900A), refer to electrical drawings for panel location. For exterior installation locations see Specification 409601. For interior installation locations see Specification 409602.
2. The contractor shall furnish, install and commission a separate Motor Control Panel (MCP-900B) for VFDs/ motor starters as outlined. Refer to electrical drawings for panel location and mounting requirements. The enclosure shall be NEMA 4X SS for exterior locations and Nema 4 for interior locations. The motor control panel shall include but limited to: VFDs / motor starters as outlined, power supply, main 3 phase disconnect C/W front door handle, breakers, fuses, line reactors, terminals, etc. Provide adequate panel heating/cooling to meet panel interior components environmental requirements. All VFDs shall communicate with Remote PLC Panel via Ethernet. Each VFD shall have a front door mounted HIM module. Each motor (VFD/Motor Starters) shall have a front door mounted HOA with green run indicator light and red fault indicator light. VFD manufacturer shall be AB Powerflex or approved equivalent.

3. All respective system field mounted devices and instrumentation shall be wired to the (MCP-900A/B) for a complete operating system as shown on the Drawings and as specified herein.
4. The Contractor shall furnish and install a total of two (2) explosion proof, submersible, solids handling pumps capable of handling aerobically digested solids at 2-4% concentration.
5. Provide all necessary accessories, including guide rails, discharge base and base elbow, discharge piping, all necessary fittings and valves, low-level float in each tank, power supply, control panel, and the access hatches, for a complete operable pumping system in accordance with the following specification and as shown on the Drawings.
6. A valve vault shall be constructed to contain the check and plug valves as shown on the Drawings. Each pump shall be capable of handling raw, unscreened domestic sewage consisting of water, fibrous materials, and up to 3-inch diameter spherical solids.

1.3 QUALITY ASSURANCE

- A. All pumping equipment furnished under this Section shall be of a design and manufacture that has been used in similar applications and it shall be demonstrated to the satisfaction of the Owner that the quality is equal to equipment made by that manufacturer specifically named herein.
- B. Manufacturers with 20 or more years of experience who have furnished at least 20 similar lift stations that have been in regular operation not less than 5 years will be considered. Evidence of experience and operational data may be required from the manufacturer to determine the suitability and efficiency of the equipment offered.
- C. In addition to requirements of these specifications, comply with manufacturer's instructions and recommendations for work.
- D. Provide equipment that is a standard product of the manufacturer.
- E. To assure compatibility, all equipment items furnished under this specification shall be furnished by a single manufacturer who shall be responsible for the adequacy of design.
- F. Each completed and assembled pump/motor unit shall undergo the following factory tests at the manufacturer's plant prior to shipment. The Manufacturer shall provide on demand a copy of his quality control plan for these tests and an ISO 9001 factory certificate:
 1. Minimum 3-point hydraulic performance test.
 2. No-Leak seal integrity test.
 3. Electrical integrity test.
- G. Under this Contract, the Contractor shall be responsible for the purchase, storage, and installation of all equipment required providing a complete operating facility. The Drawings and Specifications are intended to illustrate and define the equipment installation; however, the Contractor shall properly install, adjust, and place in operation the complete installation. The Contractor shall assume full responsibility for additional costs which may result from unauthorized deviations from the Specifications.

1.4 SHOP DRAWINGS AND SUBMITTALS

- A. The Contractor shall submit manufacturer's technical data and application instruction in accordance with the General and Supplementary Conditions and Division 1 Specifications and any additional information listed herein.
- B. Product Data: Submit the manufacturer's technical data and installation instructions including certified pump curves with efficiency, capacity, head, speed, brake horsepower required, and operating point required for each pump. The Contractor shall submit, as a minimum, the following information:
1. Manufacturer: pump and motor
 2. Pump: weight
 3. Casing: material
 4. Motor jacket: type of material (if applicable)
 5. Casing bolts and nuts: material
 6. Impeller: material, design, coating
 7. Wear ring: number, location, material
 8. Shaft: material, diameter, length
 9. Mechanical Seals: type, upper and lower seal material, spring material, O-ring material, other material of construction.
 10. Motor: type, NEC Article 500 rating, insulation class, service factor, continuous duty ambient temperature, starts per hour
 11. Thermal switches: number, temperature setting
 12. Float switch: type, material
 13. Coatings: primer type, finish type, number of coats, total dry film thickness, suitability for media being pumped
 14. Guide system: type, size, material
 15. Pressure gauges
 16. Minimum submergence and NPSH required at all design points.
 17. Spare parts: number and type
 18. Motor controls including enclosure, circuit protection, disconnects, starters, transformers, phase monitor, switches, relays and contacts, lights, meters, timers, alternators, strip heater, alarms, and fuses. On shop drawings, indicate equipment location, rough-in and anchor placement dimensions and tolerances, clearances required and elevation. Also submit, with drawing data, the appropriate characteristic head/capacity curve for the pumps and motors to be provided. Submit all wiring diagrams.
- C. Shop Drawings: All shop drawings shall clearly identify the specific equipment and material being supplied, the quantity being supplied, and all accessories, dimensions, weights, descriptions, mounting and connection details, and any other information necessary to determine compliance with the plans and specifications. The Contractor shall Submit, as minimum, the following information:
1. Dimensions of pump; discharge and guide rails.
 2. Plan view of pump indicating clearances required for hatch openings.
 3. Pump layout, spacing requirements.
 4. Motor data, including starting kVA, starting torque, full load current, full load torque efficiency curves, and power factor curves (computer model printouts not acceptable).

5. Where required, verification that the variable speed drive is capable of delivering the required torque and power over the entire speed range of the pump.
 6. Control panel, wiring diagrams for all electrical work.
 7. Deviations from Contract Document.
- D. Manufacturer's Certificates, including certified test curves with the design points clearly marked (computer model printouts are not acceptable) shall be submitted and approved by the Engineer prior to the pump(s) shipment. Performance curves shall be submitted for each pump to be supplied to both the Engineer and the Owner.
1. Each pump shall be shop tested for capacity, head, speed, power and efficiency in accordance with Standards of the Hydraulic Institute.
 2. Tests shall consist of checking each pump at its rated speed, head, capacity, efficiency, and brake horsepower; and at such other conditions of head and capacity to properly establish the performance curve.
 3. The required shaft power (P2) in the guaranteed duty point shall be less than rated pump motor horsepower (HP).
 4. The pump hydrostatic and performance testing shall be submitted 30 days prior to delivery.
- E. O&M Manuals: Prior to or with the delivery of equipment, the Manufacturer shall provide electronic copy of an Operation and Maintenance Manual for Engineers review. O&M Manuals shall contain copies of the approved shop drawings, equipment storage, installation, startup, operating and maintenance instructions, and a complete parts list and recommended spare parts list. The O&M Manuals shall be in compliance with the General Requirements.
- F. Manufacturer's Installation Instructions: Indicate installation procedures and interface required with adjacent work.
- G. Installation Report: The equipment manufacturer shall also submit a written report stating the equipment:
1. Is properly installed.
 2. Is in accurate alignment.
 3. Is properly lubricated.
 4. Has been tested and operated satisfactorily.
- H. Warranty: The Equipment Manufacturer shall submit a warranty certificate for review for all pump equipment. Warranty shall be against mechanical failure due to materials and workmanship or abrasive wear under the original specified operating conditions.

1.5 WARRANTY

- A. All equipment furnished shall be warranted per Section 013325. The pump manufacturer shall warrant all equipment to be of quality construction, free of defects in material and workmanship.
- B. The manufacturer shall warrant, in writing, that all equipment supplied by them shall be free from defects in material and workmanship, for a period of twelve (12) months from the date of startup, or eighteen (18) months from the date of delivery, unless noted

otherwise within the specifications. The warranty shall be in printed form and previously published as the manufacturer's standard warranty for all similar units manufactured, latest revision. Upon warranty occurrence, the manufacturer's authorized service center shall remove the pump, repair, reinstall and provide start up on the repaired pump. A detailed failure analysis shall be submitted to the Owner for their records summarizing corrective action taken.

- C. The manufacturer shall guarantee clog-free operation for a period of 24 months from the date of start-up of the pumps by the local authorized factory representative. A certificate shall be provided to the Owner on the day of start up with the local contact information and effective date.
- D. The pumps shall be provided with prorated 60 months (5 years) warranty against defects in materials and or workmanship.
- E. Any defects found within the warranty period shall be replaced if damaged or defective in the normal use of the equipment at no cost to the Owner.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Comply with Section 016600, Product Handling and Protection.
- B. Handling, delivery, and storage of the equipment shall be in accordance with the Manufacturer's recommendations. No extra cost shall be charged the Owner for the handling, delivery, or storage of the equipment.

PART 2 - PRODUCTS

2.1 MANUFACTURER

- A. The submersible pumps shall be in compliance with these specifications and plans and shall be supplied by the following manufacturer:
 - 1. Flygt
 - 2. KSB
 - 3. Or approved equal.
- B. Equipment Schedule is provided at the end of this section.

2.2 PUMP CONSTRUCTION

- A. General:
 - 1. Submersible non-clog wastewater pump shall be designed as a completely submersible raw sewage pump capable of pumping grit and screenings.
 - 2. Pumps shall include, but not be limited to all drives, pump bases, pumps, connection discharge, level sensors, minimum 2-inch 316 stainless steel bracket guide rails, 3/16 inch - 316 stainless steel chain, anchor bolts, submersible cable, electrical control panels and other appurtenances as specified or required for a complete installation.

3. The pumping units shall come complete with sliding brackets, motors, guide bars, stainless steel pull chain, power cables and all other necessary appurtenances.
4. Pumps and level control primary instruments shall be easily removable for routine service without the need for personnel to enter the wet well. This shall be accomplished by utilizing a sliding guide bracket attached to the pump and adequately braced; a stainless steel lifting cable provided for each pump; and a specially formed discharge flange that automatically and firmly connect and disconnect with the discharge pipe without bolts, nuts, fasteners, or extreme force.
5. The pumping units shall come complete with, motors, power cables and all other necessary appurtenances to provide a complete operating system.

B. Material of Construction:

1. The parts exposed to abrasive wear – case, impeller, wear plate and base elbow – shall be of all High Chrome Iron material conforming to ASTM Designation A532 - 75 Class I, Type A or A532 IIC 15%CrMo, and be a minimum of 600 Brinell hardness for maximum wear resistance.
2. All nuts or bolts, and miscellaneous hardware in contact with the pumped material shall be AISI 316 stainless steel construction.
3. Motor Housing, seal housing: Cast Iron, Class 25 ASTM A48-7
4. Cord Cap and Volute Case: Cast Iron, Class 25 ASTM A48-76
5. Power and control Cords: 50 ft
6. Mechanical Seals: Double tandem Type 21 carbon & ceramic; lower tungsten carbide; or silicon carbide upper and lower seals.
7. Pump Motor Shaft: minimum 416 SS
8. Fasteners: 316 SS

C. Submersible Motors

1. The pump motor shall be induction type with a squirrel cage rotor, shell type design, housed in an air filled, watertight chamber. It shall be permanently submersible according to standards IEC 60034 and protection class IP 68.
2. It is the intent of this specification to define submersible premium quality motors, which will provide efficient operation with high mechanical integrity under adverse operating conditions for maximum life and minimum life cycle costs. These specification covers sewage wet well applications defined by the National Electric Code as Class 1; Division 1, hazardous locations section 501-8(a) requiring explosion proof construction.
3. Motor shall not overload for the entire pump curve performance range.
4. The pump shall be capable of operating in a continuous condition in a liquid with a temperature up to 104°F even when the motor is not submerged.
5. The motor shall be capable of no less than 30 evenly spaced starts per hour and be able to operate throughout the entire pump performance curve from shut-off through run-out.
6. The stator windings shall be insulated with moisture resistant Class H insulation rated for 356°F.

D. Mechanical Requirements

1. Bearings and Lubrication

- a. The pump shaft shall rotate on two bearings with a nominal L10 lifetime of 50,000 hours. The upper bearing shall be a single deep groove ball bearing.
 - b. The lower bearing shall be a two-row angular contact bearing to compensate for axial thrust and radial forces. Single row lower bearings are not acceptable.
 - c. The motor shall be designed to limit the bearing temperature rise to a maximum of 60° C under full load conditions.
 - d. Motors shall be greased by the manufacturer with premium moisture resistant polyurea thickened grease containing rust inhibitors and suitable for operation over a temperature range of -25° C to +120° C.
2. Shaft Seal: Each pump shall be provided with a positively driven dual, tandem mechanical shaft seal system consisting of two seal sets, each having an independent spring.
- a. Each pump shall be provided with a lubricant chamber for the shaft sealing system. The lubricant chamber shall be designed to prevent overfilling and to provide lubricant expansion capacity. The drain and inspection plug, with positive anti-leak seal shall be easily accessible from the outside. The seal system shall not rely upon the pumped media for lubrication. Seal lubricant shall be non-hazardous.
 - b. The lower primary seal, located between the pump and seal chamber, shall contain one stationary and one positively driven rotating corrosion and abrasion resistant tungsten-carbide or silicon carbide ring.
 - c. The upper secondary seal, located between the seal chamber and the seal inspection chamber shall be a leakage-free seal. The upper seal shall contain one stationary and one positively driven rotating corrosion and abrasion resistant tungsten-carbide or silicon carbide seal ring.
 - d. The rotating seal ring shall have small back-swept grooves laser inscribed upon its face to act as a pump as it rotates, returning any fluid that should enter the dry motor chamber back into the lubricant chamber.
 - e. All seal rings shall be individual solid sintered rings. Each seal interface shall be held in place by its own spring system. The seals shall not depend upon direction of rotation for sealing. Mounting of the lower seal on the impeller hub is not acceptable.
 - f. Shaft seals without positively driven rotating members or conventional double mechanical seals containing either a common single or double spring acting between the upper and lower seal faces are not acceptable.
 - g. The seal springs shall be isolated from the pumped media to prevent materials from packing around them, limiting their performance. Any leakage passing the sealing shall not pass the bearings. Before it reaches the bearings, the liquid shall create an alarm via the floating leakage sensor.
 - h. Moisture Protection System
 - 1) One (1) moisture sensing probes are to be provided that extend into the oil chamber located between the outer and inner seal and used to detect the presence of moisture should the outer seal fail, if applicable.
 - 2) The moisture protection system shall also be designed to detect water in the motor chamber and provide a warning signal prior to water levels reaching the bearing or wound stator assemblies.

3. Guide Bars

- a. It shall be possible to lift and lower the pumps on parallel guide bars and connect them to wet well mounted discharge connection. There shall be no need for personal to enter the wet well when removing or reinstalling the pumps.
 - b. Pump and guide rail assemblies shall comply with the requirements for NEC Article 500 Class 1, Div. 1, Groups C and D, hazardous location, explosion-proof service or as listed in the Pump Schedule.
 - c. The pump(s) shall be automatically and firmly connected to the discharge connection, guided by no less than two parallel guide bars extending from the top of the station to the wet well mounted discharge connection. The material of the guide bars shall Stainless steel AISI 316. The guide bars shall be fastened at the top of the station with a guide bar holder made of Stainless steel AISI 316.
4. Discharge Connection
- a. The sealing of the pumping unit to the discharge connection shall be accomplished by a machined metal to metal contact. Sealing of the discharge interface with a diaphragm, O-ring or profile gasket will also be acceptable.
 - b. The entire weight of the pump/motor unit shall be borne by the pump discharge elbow. No portion of the pump/motor unit shall bear on the sump floor directly or on a sump floor mounted stand.
 - c. For each pump the contractor shall supply and install a discharge connection made of cast iron ASTM A-48, Class 35B.
 - d. The outlet flange of the discharge connection shall be drilled according to ANSI B16.1-89.
5. Cap/Cable Assembly
- a. The motor shall be equipped with 50 feet of screened cable suitable for submersible pump applications. The power cable shall be sized according to NEC and ICEA. The outer jacket of the cable shall be oil resistant chlorinated polyethylene or synthetic rubber. The cable shall be capable of continuous submergence underwater without loss of watertight integrity to a depth of 20 feet.
 - b. The power cable and cap assembly shall be designed to prevent moisture from wicking through the cable assembly even when the cable jacket has been punctured.
 - c. Power and control cable entry into the lead connection chamber shall be epoxy encapsulated for positive moisture sealing.
 - d. A Buna-N power and control cable grommet shall be provided in addition to the epoxy to the epoxy sealed leads.
 - e. The submersible cable of the pump shall be connected to the cable from the Control panel in a floor or wall mounted cable connection box to ease the installation and disassembling of the pumps and keep the submersible cables as short as possible.
 - f. The cable connection box shall be submersible NEMA 6P to secure that no water can enter the motor via the cables even when the complete area is flooded.
 - g. The junction chamber containing the terminal board shall be hermetically sealed from the motor by an elastomeric compression seal. Connection between the cable conductors and stator leads shall be made with threaded

compression type binding posts permanently affixed to a terminal board. The motor and the pump shall be produced by the same manufacturer.

- h. The motor shall be protected by 3 thermal switches embedded in the stator set to open at 285°F (140°C) and one leakage sensor floating type located in the stator chamber. The sensor and the switches shall be connected to the control panel which shall stop the motor and send an alarm when the sensors are activated.
 - i. The cable entry shall consist of dual cylindrical elastomer sleeves, flanked by washers, all having a close tolerance fit against the cable and the cable entry.
6. Enclosure and Shaft
- a. The motor enclosure including frame, end brackets, flange and cap assembly shall be cast iron, ASTM type A-48, Class 25 or better.
 - b. Motor frame construction shall not have fins and shall be a smooth surface to prevent the clogging of solids and provide for easy cleaning.
 - c. The top end bracket will include integrally cast provisions for vertical lifting capability.
 - d. All mating frame fits to have rabbet joints with large overlap as well as O ring seals for a watertight seal.
 - e. Standard O-rings shall be Buna-N (nitrile).
 - f. Motor shaft shall be minimum 420 stainless steel.
 - g. All external hardware including the motor nameplate shall be made of stainless steel.
 - h. All exposed motor parts including frame, brackets, flange, and cap assembly shall receive an alkyd primer and epoxy ester finish coat of high-grade paint to resist rust and corrosion.
7. Electrical Requirements
- a. All motors covered by this specification shall conform to the latest applicable requirements of NEMA, IEEE, ANSI and NEC standards.
 - b. Motors shall be designed for continuous submerged duty in water and sewage, and minimum 15-minute duty continuous in air under full load operating conditions.
 - c. 3-Phase motors shall be rated 460 Volts.
 - d. Motor construction shall be designed to withstand 200-psi water pressure at all seal locations.
 - e. All motors shall be rated as Class H, 1.15 service factor, Class 1, Groups C & D.
 - f. All motors shall be U.L. (Underwriters Laboratories) or FM approved, and name plated accordingly.
 - g. The ability to provide any/all replacement parts, engineering design support, complete dynamometer testing, and U/L rerate capability shall be provided domestically.

2.3 ELECTRICAL CONTROLS

- A. The Contractor shall furnish all labor, equipment and materials to install pump controls as shown on the Drawings, for operation on a 480 volt, 3 phase, 60 Hertz, 3 wire system.

- B. The pumps shall be fed and controlled from the local control panel, provided with control circuit transformers with disconnects and overload protection.
- C. Local control stations shall be provided by the pump supplier as specified herein, per Specifications Divisions 26 and 40 and Contract Drawings.
- D. For each pump motor, the following shall be provided in the local control panel: a combination circuit breaker/overload unit providing overload protection, short circuit protection, manual reset; across-the-line magnetic contactor or VFD as shown on the Drawings; hand/off/automatic pump operation selector switch; necessary auxiliary isolated contacts for computer/SCADA system interface; pump running pilot lights; running time meters; motor monitoring relays as required to interface with the sensors/detectors mounted at the motor.
- E. Operation in Automatic Mode shall be initiated via signals from SCADA system, which will accomplish motor alternation for even wear and enable multiple motors, when high level conditions persist.
- F. If a motor is disabled (e.g. overload, overtemp, or in off position) it shall shut down and lock out. If the faulted motor is lead, an induced alternation shall occur. If the faulted motor is lag, the next motor shall automatically substitute.

2.4 ACCESSORIES

- A. All accessories shall be provided as shown on the Drawings and specified herein.
- B. Radar Level Transmitter for the Influent Pump Station and RAS/WAS Pump Station:
 1. CSA approved according to Class I Zone 0, Gr. IIC and Div.1 Gr A, B, C&D
 2. Material of casing: Polypropylene.
 3. Degree of protection: NEMA 7.
 4. They shall be applicable for liquids with a density of 0.95 – 1.10 g/cm³. The Level control shall include 50 feet submersible cable.
 5. Equipped with 4-20 mA signal.
 6. Contractor shall provide readout and cabling to Control Panel per Division 26.
 7. Manufacturer: Flowserve, Rosemount Instruments Inc., Kobold Instruments Inc., IFM Efector.
- C. Ultrasonic Level Sensor (Tertiary Filter Pump Station):
 1. CSA approved according to Class I Zone 0, Gr. IIC and Div.1 Gr A, B, C&D
 2. Material of casing: Polypropylene.
 3. Degree of protection: NEMA 7.
 4. They shall be applicable for liquids with a density of 0.95 – 1.10 g/cm³. The Level control shall include 50 feet submersible cable.
 5. Equipped with 4-20 mA signal.
 6. Contractor shall provide readout and cabling to Control Panel per Division 26.
 7. Manufacturer: Flowserve, Rosemount Instruments Inc., Kobold Instruments Inc., IFM Efector.

- D. Provide a float-based level system to serve as a back-up control and high-level alarm, as shown on the drawings.
1. The Influent Pump Station shall be equipped with six (6) backup float switches.
 2. (1) High-High Level Alarm; and (2) Low-Level Alarm and to initiate pump “Stop”
 3. The Tertiary Pump Station shall be equipped with four (4) backup float switches.
 4. The RAS/WAS Pump Station shall be equipped with three (3) backup float switches.
 5. Aerobic Digesters No. 4 &5 shall be equipped with one (1) backup float switch for the Low-Level Alarm and to initiate pump “Stop” at low water level set point.
 6. Float switches shall be mercury switches hermetically sealed within the float suspended with 3-conductor immersion-rated control cable with cast iron weight affixed to cable above the float. Switch contacts shall be used in pilot-control circuits and be rated 12 amps at 115- or 230-volt AC.
 7. Float switches shall be attached to a weighted stainless steel chain which will be fastened to a stainless steel eye bolt accessible from the top of the wet well without entering the wet well for removal.
- E. Pressure Gauges:
1. Pressure Gauges shall be provided for the Influent Pumps, Tertiary, RAS/WAS, and Aerobic Digesters No. 4 & 5 submersible Pump Stations. Contractor is responsible for proper installation of the pressure gauges per manufacturer recommendation and as shown on the Drawings.
 2. Pump force main shall be tapped for gauge connection located in the Valve Vaults.
 3. Gauge connection shall be 1/2-inch diameter.
 4. Each connection shall include a shutoff needle valve and necessary length of pipe to allow the mounting of a pressure gauge. The open end of the gauge connection shall be plugged to prevent the accumulation of debris.
 5. The pressure gauges shall be liquid filled with the silicone oil, supplies with snubber and diaphragm seal. The gauges shall be adequately sized to indicate discharge pressure.
 6. The pressure gauges installed on the discharge side shall operate over a range of 0-50 psig.
 7. Manufacturer: Gauges shall be a product of H.O. Trerice, Ashcroft, Wika or equal.
- F. A slide rail assembly consisting of minimum 2-inch Schedule 40, 316 stainless steel shall be provided to allow the pumps to be installed or removed without requiring personnel to enter the wet well. Each guide rail system shall include the following items:
1. The lift-out rail system shall be of non-sparking design and shall be UL listed for Class 1, Group D explosion-proof service.
 2. The stationary fitting shall have a Neoprene diaphragm clamped between the stainless steel rail and the stationary cast iron discharge.
 3. Discharge elbow with mounting bracket.
 4. Flanges
 5. Stainless steel upper guide rail mounting bracket.
 6. Stainless steel intermediate guide bracket must match and mate with new pump proposed.

7. The cast iron moveable fitting when in position shall be held against the stationary fitting by the construction of the stainless steel rail aligning the moveable fitting to the flexible diaphragm for proper sealing of the two surfaces under pressure.
 8. The guide rail base assembly shall support the pump at the required distance from the basin floor to provide unrestricted flow of material into the pumps.
 9. Lifting Cable: 50 feet of 1/4-inch stainless steel lifting cable with a swaged ball fitting compatible with the Owner's portable winch assembly.
- G. For each pump the contractor shall supply and install a chain/cable holder made with 4 hooks of Stainless steel AISI 316.
 - H. Each pump shall be fitted with 35 feet of stainless steel lifting chain. The working load of the lifting system shall be 50% greater than the pump unit weight.
 - I. Contractor shall furnish stainless steel anchor bolts with nuts and washers, as recommended by pump manufacturer.
 - J. All machine bolts, nuts and cap screws shall be of the hex head type. Hardware or parts requiring special tools or wrenches shall not be used.
- 2.5 SHOP PAINTING
- A. All surfaces shall be thoroughly cleaned of dirt, grease, oil, rust, scale, or other injurious substances. All metal surfaces shall be sandblasted in accordance with SSPC-SP10, Near-White Blast Cleaning.
 - B. All metal surfaces which shall be partially or wholly submerged shall receive a shop coat of polyester resin primer. All non-galvanized metal surfaces which will be above water surfaces shall receive a shop coat of a universally compatible primer.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Installation shall be in accordance with Contract Drawings and manufacturer's shop drawings, instructions, and recommendations.
- B. The manufacturer shall provide installation assistance and certification as required for proper installation prior to start-up.

3.2 INITIAL LUBRICATION

- A. Initial lubrication required for startup and field test operation shall be furnished and applied in accordance with the manufacturer's recommendations.

3.3 INSPECTION, STARTUP, AND TESTING

- A. The manufacturer shall furnish the services of a qualified representative for a period of not less than three (3) work-days to inspect, make final adjustments, supervise initial startup of each pump.
- B. This qualified representative shall also conduct tests as necessary to demonstrate satisfactory operation and to instruct the Owner's personnel in the care and operation of the equipment.
- C. The representative shall complete a start-up report for the Owner before final acceptance of the pumps.
- D. If additional service is required due to the mechanisms not being fully operational, at the time of service requested by the contractor, the additional service days will be at the contractor's expense.
- E. For the purposes of this section, a work-day is defined as an eight hour period at the Site, excluding travel time.

3.4 PUMP TEST

- A. Unless otherwise noted, certified performance data based upon tests of each actual pump proposed to be furnished shall be submitted to the Engineer for acceptance. Tests shall be performed in accordance with the Test Code of the Hydraulic Institute Standards and shall demonstrate compliance with the operating conditions specified.

3.5 MOTOR TEST

- A. Tests shall be performed in accordance with the American Standard Test Code.
- B. Short commercial test: For motors of less than 25 Hp, a certified report of the short commercial test of each actual motor proposed to be furnished shall be submitted to the Engineer for acceptance.
- C. Complete Test: For motors of 25 Hp and greater, certified motor efficiency curve at 100, 75, and 50 percent of full load based upon a complete test of a motor of identical design specifications to the motor proposed to be furnished shall be submitted.

3.6 OPERATION AND MAINTENANE MANUALS

- A. Operation and maintenance (O&M) manuals shall be provided prior to or with the delivery of the equipment. The O & M manuals shall include instructions on storage, installation, start-up, and operation and maintenance, together with a complete parts list and a recommended spare parts list. The O & M manuals shall be in compliance with the General Requirements.

3.7 PUMP SCHEDULE

- A. Influent Pumps

Type of Pump	Submersible
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Pump Rating	FM listed for Class 1, Div. 1, Groups D explosion-proof
Number Required	4
Pumped Liquid	Raw sewage
Non-compressible solids passage	3-inch diameter spherical solids
Design Capacity (each)	2,400 gpm
TDH	52 ft
Max. Motor Size	60 HP
Min. Efficiency at Pump Design Capacity	77%
Max Motor Speed	1800 rpm, with 60 HP rated VFD
Power Requirements	460 V, 3 ph, 60 Hz
Discharge Size	8"
Suction Size	125 lb. ANSI flange

B. Tertiary Filter Pump Station

Type of Pump	Submersible
Pump Rating	Unclassified
Number of pumps installed	3
Pumped Liquid	Tertiary Filter Effluent – Clean Water Operation
Design Capacity (each)	3,000 gpm
TDH	30 ft
Max. Motor Size	40 HP
Min. Efficiency at Pump Design Capacity	75%
Max Motor Speed	1800 rpm, VFD
Power Requirements	460 V, 3 ph, 60 Hz
Discharge Size	12"
Suction Size	12" 125 lb. ANSI flange

C. RAS Pump Station

Type of Pump	Submersible
Pump Rating	FM listed for Class 1, Div. 1, Groups D explosion-proof
Number Required	2, one pump for operation and second standby
Pumped Liquid	Raw sewage
Non-compressible solids passage	3-inch diameter spherical solids
Design Capacity (each)	2,100 gpm
TDH	56.6 ft
Max. Motor Size	45 HP
Min. Efficiency at Pump Design Capacity	78%
Max Motor Speed	1800 rpm, with 60 HP rated VFD
Power Requirements	460 V, 3 ph, 60 Hz
Discharge Size	8"
Suction Size	125 lb. ANSI flange

D. Aerobic Digesters No. 4 and 5 Sludge Transfer Pumps

Type of Pump	Submersible
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Pump Rating	FM listed for Class 1, Div. 1, Groups D explosion-proof
Number Required	2
Pumped Liquid	Aerobically Digested Sludge at 2-4 % Concentration
Non-compressible solids passage	3-inch diameter spherical solids
Design Capacity (each)	320 gpm
TDH	28 ft
Max. Motor Size	7.5 HP
Min. Efficiency at Pump Design Capacity	62%
Max Motor Speed	1800 rpm, constant speed
Power Requirements	460 V, 3 ph, 60 Hz
Discharge Size	4"
Suction Size	125 lb. ANSI flange

END OF SECTION 432513

SECTION 433344 - CHEMICAL FEED METERING PUMPS

PART 1 - GENERAL

1.1 REFERENCE

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

1.2 DESCRIPTION OF WORK

- A. This specification includes furnishing, installing, and testing of completely functional variable speed peristaltic metering pumps, total of two (2) pumps, suitable for pumping Neo Water FX 300 (aka Rare Earth Chloride) feed to the Oxidation Ditch effluent channel, as shown on the drawings and described herein.
- B. Contractor shall furnish and install one (1) duplex, duty/standby configuration peristaltic pumps, wall-mounted skid system. Chemical metering pump system shall be a complete turnkey system inclusive of all necessary fluid handling and ancillary components to ensure the reliable metering of chemical into a treatment process, including but not limited to the following main components:
 - 1. Peristaltic Chemical Metering Pumps, duplex skid system.
 - 2. Calibration Column
 - 3. Pressure Relief Valve
 - 4. Discharge Pressure Gauge with Diaphragm Seal
 - 5. Fabricated HDPE pre-piped Wall Panel.
- C. This specification is the basis for design of peristaltic metering pumps. All pumps, whether named as an acceptable supplier or submitted as an equal shall, at a minimum, meet all critical design requirements specified herein.

1.3 QUALITY ASSURANCE

- A. Chemical Metering System (skid) must be manufactured by the chemical metering pump manufacturer and must provide pumps and accessories as a complete turnkey system.
- B. Pumps to be manufacturer's standard product. Manufacturer of tubing pumps must have at least 20 operating installations in municipal wastewater treatment plants located in the United States over a period of at least ten years in the same service and size as specified.
- C. To ensure proper function and quality, pumphead, tubing, and drive shall be manufactured by the same company. Tubing purchased by the pump manufacturer from a third party is not acceptable.
- D. Warranty: Drive and pump heads shall be 24 hr continuous duty rated and have a three-year manufacturer's warranty from date of shipment.

- E. Pumps shall be manufactured in compliance with ISO 9001-2008 standards.
- F. Pumps shall meet all applicable CE and CETL US standards per UL610101A
- G. Pumps shall be meet CE, NSF 61 and applicable electrical standards.
- H. To ensure proper function and quality, pump head, tubing, and drive shall be manufactured by the same company. Tubing purchased by the pump manufacturer from a third party is not acceptable.

1.4 SUBMITTALS

- A. Submittals shall meet the requirements of Division 1 in general and specifically include the following:
 - 1. Certified shop drawings.
 - 2. Characteristic performance curve showing flow rate as a function of RPM and pressure.
 - 3. Dimensional drawings.
 - 4. Chemical Metering System Arrangement & Installation drawings.
 - 5. Operating, maintenance, programming, and wiring instructions for all equipment.
 - 6. Tool-free pump head replacement instructions.
 - 7. Manufacturer's certification that pump head, drive, and tubing are all manufactured by the same manufacturer.

1.5 DELIVERY, STORAGE, & HANDLING

- A. Delivery, storage, and handling shall meet the requirements of manufacturer/supplier in general and the following specifically:
 - 1. Shipping: Ship the Chemical Metering System completely assembled and ready for installation.
 - 2. Pack all additional spare parts in containers bearing labels clearly designating contents and pieces of equipment for which intended.
 - 3. Deliver spare parts at the same time as equipment. Deliver to Owner after completion of work
- B. Receiving
 - 1. Contractor shall inspect and inventory items upon delivery to site.
 - 2. Contractor shall store and safeguard equipment, material, instructions, and spare parts in accordance with manufacturer's written instructions.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. The peristaltic pumps shall be manufactured by:
 1. Watson-Marlow, Inc., Model Qdos 120 Duplex Wall Panel, One (1) Duplex-Duty/Standby configuration.
 2. Or approved equal.

2.2 DESIGN REQUIREMENTS

- A. The pumps assembly shall include indicated equipment, piping, valves, instruments, controls, and panels as well as any disconnects, guards, supports, and accessories necessary to provide a functional unit ready for connection to building services, detached equipment, and interfacing assemblies.
- B. Interfaces: All piping interfaces between individual pumps and with external systems shall be flanges or unions as appropriate to the specific service. Electrical, monitoring and control components shall be wired to terminals in terminal boxes on each skid section. Wiring connections to external systems shall be through terminal boxes.
- C. All mounting hardware shall be series 300 stainless steel, including bolts, anchor bolts, washers, and nuts. When galvanized steel is required, mounting hardware shall be hot-dip zinc coated galvanized in conformance with ASTM A153, and bolts and hex nuts shall conform to ASTM A307, Grade A.

2.3 CHEMICAL METERING SYSTEM SCHEDULE

- A. Schedule - A: NEO Chemical Metering Pump Process Schedule

Quantity of Chemical Metering Pumps	2
Fluid	Neo Water FX 300 (aka Rare Earth Chloride) Specific Gravity of 1.26-1.63 @ 68°F pH 3.3-4.0
Flow Range Min-Max	0-31.5 GPH
Average Flow	7.88
Discharge Pressure, psi	10 psi
Maximum Pressure rating, psi	60 psi
Application Points:	- Oxidation Ditch Effluent Channel
Flow Control	20,000:1 with ±1% accuracy
Max Pump Speed, rpm	140 RPM
Speed Control range	0.006-140 RPM
Power (VAC, Frequency, Phase)	115VAC, 60 Hz, 1 Phase

2.4 PUMP CONSTRUCTION

- A. Pump Head
 1. Technology: Provide tool-free ReNu cartridge-style peristaltic pump head technology. For operator safety, pump head shall be serviceable as a single replaceable component. Pumps that require an operator to open the pump head for

tube replacement, cleaning, or rebuilding or that require tools for maintenance are unacceptable.

2. Max rating: 31.7 GPH at 140 rpm and 60 psi of discharge pressure.
3. Housing construction: Corrosion resistant and high impact resistant glass filled PPS.
4. Geometry: Pump head shall consist of sealed track housing with in-line porting. Suction and discharge ports shall be 180-degrees apart with bottom suction and top discharge.
5. Rotor: Pump head rotor shall be constructed of glass filled Nylon, sealed within the track housing, and supported by its own bearings. Peristaltic occlusion level shall be factory set to ensure flow accuracy of +/- 1% and repeatability performance of +/- 0.5% and shall not require any field adjustment.
6. Leak containment/detection: In the event of peristaltic element failure, the leak sensor shall shut the pump down immediately with all process fluid contained within the sealed pump head.
 - a. Sensor type: Utilize non-contacting optical sensor. Sensor shall not come in contact with the process fluid, shall contain no moving parts, shall not depend on the capacitance of the process fluid, shall not require fluid to leak out of the pump housing for engagement, nor shall require any sensitivity or calibration adjustment.
 - b. Alarm: Sensor shall shut down the pump, give a visual indication on the drive controller, and if specified shall provide an output general alarm signal.
 - c. For operator and environmental safety, pumps which do not have leak containment, leak sensor, and shutdown are not acceptable. For additional overpressure safety, sealed pump head shall have a controlled drain-to-waste port.
7. Port connections: Pump head shall utilize compression fittings with PVDF tube nozzles and HDPE clamp rings which shall mate to polyethylene interface hoses. Provide polypropylene compression by 1/2-inch NPT adaptors for connecting interface hose to chemical metering system hard piping.
8. Spares: Provide one (1) spare pump head per pump supplied.

B. Drive

1. Rating: Continuous 24-hour operation, 45o C ambient.
2. Voltage: Drive shall be suitable for 100-240VAC, 50-60Hz, 1- Phase with an internal switch-mode power supply. Supply nine- foot length mains power cord with standard 115VAC three-prong plug.
3. Max drive power consumption: 190VA.
4. Enclosure: NEMA 4X constructed out of corrosion and impact resistant engineering plastic, 20% Glass filled PPE/PS. By nature of the environmental conditions, painted or unpainted metallic housing including 316 SS are not acceptable. Enclosure shall house the drive motor and all control circuitry in one integrated unit. Separate VFDs and motors are not acceptable.

5. Direct coupled pump head with fully protected drive.
 - a. Pump head shall direct couple mount to the controller via a splined drive shaft and shall be locked in place by two tool-free thumbscrews or lever mechanism.
 - b. Pump head shall be fully sealed to prevent any contamination of the controller or drive shaft by process fluid.
 - c. Pump head shall contain its own rotor bearings and not impart an overhung load on the pump shaft.
 - d. Pump head shall be supplied mounted to the left side of the drive enclosure.
 - e. Drive shall stop shaft rotation and give visual alarm in the event the pump head is removed.
 6. Drive motor: brushless DC motor with integral gearbox and closed loop tachometer feedback.
 - a. Circuitry complete with temperature and load compensation and protection.
- C. Human-Machine Interface (HMI) and Control
 1. Manual Control Interface
 - a. Flow range: Qdos 120- flow range from 0.001-31.7 GPH in 0.001 GPH increments
 - b. Display: Backlit graphical TFT Display capable of up to 8 lines of text with up to 26 characters per line to display pump tag number, flow rate, and programming instructions. Display shall also provide visual indication of running status via screen color: Blue = Running; White = Stopped; and Red = Warning.
 - c. Keypad: Keypad for Start, Stop, speed increment, speed decrement, rapid prime, and programming.
 - d. Flow units: Programmable in either ml/min or gallons/hour.
 - e. Security: Programmable keypad lock and PIN security for optional lockout of all keys except emergency start/stop.
 - f. Auto Restart: feature to resume pump status in the event of power outage interruption.
 - g. Multilingual menu: include programming menus in nine languages, including at a minimum English, Spanish, and French.
 - b. Fluid level monitor: Programmable flow totalization to advise operator when their supply tank is low.
- D. Remote Control I/O
 1. Speed Control Input: Analog 4-20mA speed input with 1,600:1 turndown with incremental steps of 10 micro amps. Signal shall be trimmable and speed scaleable over any part of the drive speed range. Pump shall be programmable to either increase pump speed or decrease pump speed against an increasing Analog 4-20 mA signal.
 2. Run/Stop Input: Either 5-24V industrial logic, dry contact or powered 110 VAC contacts as shown per the process and instrumentation drawings.
 3. Status Outputs: Four status outputs, 24VDC Status relay, or 110VAC Status Relay as required by the process and instrumentation drawings software configurable to indicate the following:
 - a. General Alarm status
 - b. Running/Stopped status

- c. Manual Mode status
 - d. Analog Mode status
 - e. Contact Mode status
 - f. Fluid Level status
 - g. Leak Detected status
 - h. Calibration Columns
4. Speed Analog Output: Analog 4-20mA
 5. HMI, analog connections, and mains power shall be accessible from the front or side of the enclosure.
 6. Minimum requirements: Pumps that do not meet the minimum manual and automatic control requirements as specified above are not acceptable.
- E. Calibration Columns
1. Supply Calibration Column made of clear PVC cylinder materials, sealed on both ends with appropriately sized NPT threaded ports both top and bottom. Graduation markings shall be in fractions of gallons or milliliters in proportion to the size of the column.
 2. Column shall be sized to allow a minimum 30-second draw down at maximum pump speed.
- F. Pressure Relief Valve
1. Supply Pressure Relief Valve with PVC Body and PTFE/EPDM Diaphragm.
 2. Relief Pressure shall be adjustable from 5-150 psi.
 3. Connections shall be FNPT.
- G. Discharge Gauge with Diaphragm Seal
1. Discharge Pressure Gauge shall have a 4-inch dial with a liquid filled case, with a pressure range of 0-100 psig
 2. Discharge Gauge shall be assembled to a Diaphragm Seal with a Viton Diaphragm and 1/2-inch NPT PVC process connection.
- H. Fabricated HDPE Wall Panel
1. HDPE Shelf with Back Panel shall be fabricated out of 1/2-inch and 3/4-inch sheet stock. The Shelf and Back Panel shall be fusion welded together. Metallic Shelves & Back Panels including those that are painted or coated are not acceptable.
 2. All necessary piping to incorporate the above equipment into a single turnkey chemical metering system shall be secured to the Back Panel.
 3. Back Panel shall be designed to be wall mounted.
 4. Mounting Hardware & Installation shall be supplied by the Contractor.
- I. Isolation Valves
1. All Ball Valves, sizes 1/2-inch to 4-inch, shall have union connections. All O-rings shall be EPDM or FKM based on chemical being pumped.

J. Piping

1. Polyvinylchloride (PVC) Pipe and fittings shall be manufactured of Rigid Poly Vinyl Chloride (PVC), Schedule 80. Fittings shall be heavy-duty Schedule 80 molded fittings.

K. I/O and Power Interface

1. The chemical feed skid manufacturer shall be responsible for providing a Nema 4x interface box with labeled terminal strips per pump for input and output control wires. The chemical feed skid manufacturer is also responsible for installing all control wiring from the pumps to the Nema 4x interface box. The electrical contractor is responsible for running conduit into the Nema 4X interface Box and installing input and output control wires on the terminal strips.
2. The chemical feed skid manufacturer shall be responsible for providing a prewired and piped 120V receptacle with weatherproof cover for each skid mounted pump completely independent from the control wiring. Each skid will have an electrical junction box that has been prewired from the 120V receptacle for the electrical contractor to tie into. The electrical contractor is responsible for running conduit and tying into skid mounted electrical junction box and installing 120V supply power to the skid.

PART 3 - EXCUTION

3.1 INSTALLATION

- A. Contractor shall install items as specified and as shown on the Drawings in accordance with manufacturer's printed instructions.
- B. Contractor to connect suction, discharge, vent and drain connections as required.
- C. Contractor shall supply shielded signal wiring for the required remote input and output to the connectors.

3.2 EQUIPMENT GROUTING

- A. Use high strength epoxy grout for setting all equipment in chemical handling and containment areas.
 1. Ceilcote 684-I Epoxy Grout.
 2. Dudick High Strength Epoxy Grout.
 3. Or equal.
- B. Use structural non-shrink grout for setting treatment equipment in all other areas. Structural non-shrink grout is a premixed, prepackaged, pretreated, nonmetallic, noncorrosive, non-staining product containing selected silica sands, portland cement, shrinkage compensating agents, plasticizing and water reducing agents.
 1. Master Flow 713 by Master Builders.

2. Five Star Grout by US Grout Corporation.
 3. Crystex by L&M Construction Chemicals.
 4. Or equal.
- C. Bush hammer or mechanically chip concrete surfaces that are to receive equipment grout, 8000 psi minimum compressive strength at 28 days when tested by ASTM C109. Shrinkage limited to 0.001-inch in plastic states when tested by ASTM C287 and in hardened state when tested by Corps of Engineers CRD-C621.

3.3 TOOLS

- A. Furnish any special tools that are normally required for the installation, operation, and maintenance of the equipment as defined in the individual equipment specifications. Tools shall be new, first-class quality, and shall be shipped in separate containers clearly marked with the identification of the equipment for which the special tools are intended.

3.4 EQUIPMENT LUBRICATION

- A. Lubricate equipment bearings and grease couplings per manufacturer's instructions before equipment is operated. Furnish lubricants compatible with lubricants provided or recommended by original equipment manufacturer.

3.5 IDENTIFICATION NAMEPLATES

- A. Furnish and install stamped metal identification nameplates for all equipment. Nameplates shall be 24 US standard gage (minimum) AISI 300 series stainless steel. They shall identify manufacturer, model, size, ratings, and other pertinent data indicated in individual equipment specifications. The stamped letters or numbers shall be 3/16-inch high and shall be filled in with black paint to increase readability. The name plates shall be securely connected to the equipment item by means of pins, screws, wire rings, or other acceptable means. The connecting devices shall be of a material compatible with both the nameplate and equipment at the point of attachment.

3.6 EQUIPMENT TAGS

- A. Provide tags for all process equipment.
1. Provide weather-resistant paper or plastic valve tags with the Equipment name and consecutive number clearly labeled.

3.7 TESTING

- A. All chemical feed piping shall be purged of air and completely filled with clean, dechlorinated water prior to the system tests.
- B. Testing of the chemical metering pump equipment shall be performed in conjunction with the chemical storage tank hydrotest. Operate pumps at a minimum of three different settings for a period of 24 hours each, verifying pump accuracy using the calibration columns.

- C. At the completion of the system test, all chemical feed lines shall be completely drained of water and dried.
- D. Following draining and drying, the chemical feed pipes shall be filled with their respective chemicals and purged of air.

3.8 MANUFACTURER'S SERVICES

- A. Conform to the requirements of the manufacturer's field services paragraph 1.5 of the Quality Control Section.
 - 1. Provide a minimum of 8 hours on site performing these services. Additional time required to perform these services shall be at no additional cost to the Owner. The Owner shall be credited for the unused portion of startup services.
- B. Startup services and training of Owner's personnel shall be at such times as requested by the Owner.

END OF SECTION 433344

SSSECTION 461211 – SCREW SHAFTLESS CONVEYOR

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary conditions, Division-1 Specifications sections, and all Specification Sections apply to work of this section.
- B. The following equipment and related work are specified and furnished under other items:
 - 1. Section 030000 – Concrete Work
 - 2. Section 055800 – Metal Fabrications
 - 3. Section 099700 – Special Coatings
 - 4. Division 26 – Electrical
 - 5. Section 467331 – Sludge Dewatering, Section

1.2 SUMMARY

- A. The Contractor shall provide two (2) shaftless screw conveyor for the conveyance of dewatered sludge to sludge drying bed as shown on the plans. The unit will receive dewatered sludge, conveying it to sludge drying bed without spillage or carryback of material. The length of the sections of the conveyor, and the angle of the inclined section, is shown in Schedule 461211 – A. The exact final dimensions to be determined by the Contractor to suit the dewatering equipment and the conveyor system to be used, as well as the plant layout.
- B. Screw Conveyors with shafts and intermediate hanger bearings will not be acceptable for this project.
- C. Furnish equipment complete with all supports; all mechanical equipment required for proper operation, including complete drive units; motor operated slide gates, control panel, all steel and other metal construction specified herein; and all additional materials or fabrication as required by the supplier's design.
- D. The contractor is responsible for coordination of all mechanical & electrical equipment, and structural interconnecting or otherwise interfacing with the conveyor and any site measurements required for a detailed conveyor submittal.

1.3 PERFORMANCE REQUIREMENTS

- A. The shaftless screw conveyor shall meet the performance and design requirements as listed in Schedule 461211 – A. Conveyor selection design standards to be based on the operational experience of the manufacturer with shaftless screw conveyors.
- B. Conveyor rotational speeds shall not be greater than herein specified unless availability of the reducer ratio requires slight adjustment (± 3 rpm) or if shown by the conveyor manufacturer calculations to be required to meet design load. Deviations from specified speed cannot be utilized to reduce the conveyor trough and spiral size. Faster speeds are utilized to prevent the

fluidization or apparent thinning when conveying dewatered sludge, to reduce liner and spiral wear from abrasive material.

1.4 SUBMITTALS

- A. General: Submit the following in accordance with conditions of Contract and Division 1 Specification Sections.
- B. Product Data:
 - 1. Submit Manufacturer's literature, warranty technical data and installation instruction complete with accessories, catalog cuts, drawings, specifications, fabrication details and parts identification for all work of this Section.
 - 2. Torque calculations for the gear reducer and reducer motor.
 - 3. Horsepower calculation for the drive motors.
 - 4. Manufacturer's certification, signed by a corporate officer, informing that the proposed equipment fully complies with requirements of this specification.
 - 5. Motor characteristics and performance information.
 - 6. Gear reducer data including service factor, efficiency and materials.
 - 7. Parts list including a list of recommended spare parts.
- C. Shop Drawings:
 - 1. Manufacturer's installation drawings. Dimension drawings depicting all mechanical and electrical equipment dimensions and required clearances.
 - 2. General arrangement drawings for the proposed equipment.
 - 3. Submit support locations and loads to Engineer with shop drawing for review.
 - 4. Submit proposed hanger support locations referenced from the steel columns of the Cake Loading Building and dead and live loads at each point.
 - 5. Cut sheets for electric motors and auxiliary items.
 - 6. Complete schematic diagrams for electrical control panels.
- D. Maintenance and Operating Instructions: Maintenance and Operation manuals shall completely describe operation of the shaftless screw conveyor, start-up, optimization and maintenance operations for the equipment to be furnished under this section.
 - 1. Recommendations for short- and long-term storage.
 - 2. Detailed installation instructions, with clear step-by-step points on the correct mechanical and electrical installation procedures.
 - 3. Explanation of operating safety considerations
 - 4. Trouble shooting instructions.
 - 5. Electrical diagram.
 - 6. Manufacturer's warranty.
 - 7. Repair parts and maintenance material.

1.5 QUALITY ASSURANCE

- A. In addition to requirements of these specifications, comply with Manufacturer's instructions and recommendations for work.
- B. The shaftless screw conveyor shall be manufactured of the best quality material and workmanship.
- C. All equipment included in this section shall be furnished by a single supplier who shall be responsible for the design, coordination, and the satisfactory operation of the system.
- D. Provide evidence of at least fifteen (15) years demonstrable experience in the design and manufacture of shaftless conveyor systems. The Supplier shall have at least twenty-five (25) full-scale shaftless conveyor systems operating successfully for at least five (5) years in North America at municipal wastewater treatment plants.
- E. Any shaftless screw conveyor proposed as an "or equal" design will be subject to the Consulting Engineer's approval. If such approval is granted, the Contractor and conveyor Manufacturer will nonetheless be responsible for the resolution of any technical problems arising from the use of the "or equal" design.

1.6 WARRANTY

- A. The manufacturer shall warranty the equipment furnished under this section to be free from defects in material and workmanship for a period of twelve (12) months after the equipment was first placed into operation at the jobsite or eighteen (18) months after the equipment was first delivered to site, whichever date occurs first. Any warranted material defects found to exist shall be corrected (repaired or replaced) at no cost to the Owner.
- B. The shaftless screw liner and spiral shall be warranted for a period of three years from factory start-up against wear.
- C. Liner: For a wear indicator (two colors) liner, excessive wear shall be indicated by appearance of the bottom indicator layer (second color) along more than 30% of the conveyor length during the first three years of service. If these wear indications occur the conveyor supplier shall provide new formed and banded liner to replace all the liner in the conveyor that has excessive wear.
 - 1. Screw: Excessive wear on the screw shall be indicated by loss of more than 50% of the height of the main outer screw section over 30% of the total length of the screw. If excessive screw wear is found the conveyor supplier shall provide new screw to replace the screw in the conveyor that has excessive wear.

1.7 JOB CONDITIONS

- A. To be delivered in assembled match-marked sections ready for final installation, without the need for field welding. Knocked-down kits of parts will not be acceptable.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Subject to compliance with specified requirements, supply the shaftless screw conveyor(s) from one of the following manufacturers:

1. Spirac USA, Inc., Newnan, Georgia
2. Keystone Conveyor Corporation
3. MLM Conveying Systems, Inc.
4. Esmil Corporation.
5. Or approved equal.

2.2 MATERIALS

- A. Materials used in the fabrication of the equipment under this section shall conform to the Schedule 11312-A:
1. Chutes, Troughs, End Plates: AISI 304 stainless steel Covers, Hoppers & Supports
 2. Spiral Flighting: Special Chrome-Alloy Steel w/minimum 225 Brinell Hardness
 3. Wear Liner: UHMW Polyethylene, Duraflo® SPX™
 4. Hardware: AISI 304 stainless steel

2.3 FABRICATION

- A. The shaftless screw conveyor equipment shall include the following:
1. Troughs, Liners & Covers
 2. Spiral Flighting
 3. Chutes
 4. End Shaft
 5. Electric Motor & Gear Reducer
 6. Mounting and Support Structure
 7. Slide Gates
 8. Electrical Control Panel
 9. Safety Accessories
 10. Spare Parts
- B. All welds to be continuous unless otherwise specified. Facing surfaces of field-welded components shall be beveled and match marked.
- C. Sharp corners of all cut and sheared edges shall be made smooth by edge grinding.

2.4 POWER SUPPLY

- A. All electrical equipment shall conform to applicable standard of the National Electrical Manufacturers Association (NEMA) and the National Electrical Code (NEC). Both power and control equipment shall be insulated for not less than 600 volts even though operating voltages may be lower.
- B. Power supply to the equipment shall be 460 volts, 60 Hz, 3 ph.

- C. Power supply for electrical controls shall be 120 volts, 60 Hz, single phase.

2.5 DRIVE UNITS

- A. Each spiral conveyor shall be driven by a constant-speed gear reducer motor drive unit mounted to a bellhousing adapter flange mounted to the end plate of the conveyor.
- B. The adapter flange shall allow the leakage of any material from the conveyor trough to atmosphere rather than into the gear reducer/ motor drive unit. Direct coupling of the gear reducer/motor drive unit to the end flange of the conveyor will not be acceptable.
- C. The drive unit shall be rigidly supported so there is no visible "wobble" movement under any operating condition. In the event of a prolonged power failure or emergency system shutdown the drive system shall be designed, at a minimum, to start the conveyor from a dead stop with the trough filled at 2 times the design load for loads designed up to 67% fill rate and 1.5 times for loads designed exceeding 67% fill rate.
- D. All motors shall be of energy efficient design meeting or exceeding NEMA MG1- table 12-10 and EP Act guidelines. The motors shall be 460-volt, 60 Hz, 3 phase conforming to the General Equipment specifications, except as modified herein. Each motor shall be 40°C ambient rated, 3300 feet (1000m) altitude or lower operation, with a maximum temperature rise of 80 degree C by resistance at 1.0 service factor (95 degree C rise at 1.15 s.f.). The motors have Class B insulation with Design B speed/torque characteristics in accordance with NEMA MG1-12.35 and 12.38, and be C face type, with NEMA frame sizes.
- E. Motors shall have a 1.15 service factor and a TEFC enclosure.
- F. Gear Reducers
 - 1. All gears shall be AGMA Class II, single or double reduction, helical gear units with high-capacity roller bearings. Bearings shall be designed for the thrust loads from the fully loaded startup condition and shall have an AFBMA B-10 life of 30,000 hours.
 - 2. The reducer will be air-cooled unit with no auxiliary cooling requirement. The gear reducer shall be sized with a torque service factor of 1.5 times the absorbed power or 1.1 times the motor nameplate, at the driven shaft speed, whichever is greater.

2.6 LOCAL CONTROL PANEL

- A. The contractor shall furnish, install and commission a Remote PLC Panel (MCP-1050A), refer to electrical drawings for panel location. For exterior installation locations see Specification 409601. For interior installation locations see Specification 409602.
- B. The contractor shall furnish, install and commission a separate Motor Control Panel (MCP-1050B) for VFDs / motor starters as outlined. Refer to electrical drawings for panel location and mounting requirements.
 - 1. The enclosure shall be NEMA 4X SS for exterior locations and NEMA 4 for interior locations.
 - 2. The motor control panel shall include but limited to: VFDs / motor starters as outlined, power supply, main 3 phase disconnect C/W front door handle, breakers, fuses, line reactors, terminals, etc.

3. Provide adequate panel heating/cooling to meet panel interior components environmental requirements.
 4. All VFDs shall communicate with Remote PLC Panel via Ethernet. Each VFD shall have a front door mounted HIM module. Each motor (VFD/Motor Starters) shall have a front door mounted HOA with green run indicator light and red fault indicator light. VFD manufacturer shall be AB Powerflex or approved equivalent electrical controls shall be furnished by the manufacturer of the conveyor system and conform to the provisions, National Electric Code.
- C. Motion Failure Alarm Unit: An external conveyor mounted motion failure alarm; (alternately known as "zero speed" or "under-speed" switch) to detect spiral or drive shaft failure shall be utilized in this design. SITRANS WM100 with a NEMA 4 enclosure.
- D. Emergency Shutdown: Each conveyor shall be furnished with an emergency trip cord and safety switch. The cord shall run the full length of each conveyor. The trip switch shall immediately stop all conveyors when the switch is actuated. The switch shall be RS type by Conveyor Components Corporation or approved equal. Provide hook stick for emergency trip cord operation for the conveyors 03-06.
- E. Local Control Panel shall be equipped with:
1. Hand-Off/Reset-Auto (HOA) selector switch
 2. Emergency acknowledgement button; emergency indicator and sound horn;
- F. Components:
1. Local Control Panel shall be NEMA 4X stainless steel.
 2. Enclosure shall house the control transformer, control devices, relays, terminal blocks, and VFD.
 3. Pilot devices shall be mounted on the enclosure front panel.
 4. Two contacts shall be provided one for a RUN signal and one for FAIL signal. The contacts shall be rated at 2-AMPS, 120VAC, and resistive load.
 5. To facilitate communication between the Screw Press Programmable Logic Controller (PLC) and screw Conveyors Variable Frequency Drive (VFD), a seamless arrangement shall be established utilizing the Ethernet IP protocol.

2.7 SURFACE PREPARATION

- A. All iron and mild steel surfaces to be painted shall be dry abrasive blasted in accordance with SSPC-SP6, and in accordance with the painting Section 09801. Surfaces shall be painted or hot dip galvanized within 24 hours to prevent rusting and surface discoloration.
- B. All carbon steel frame and support members shall be prepared with a commercial sandblast (SSPC-SP6) and be finished with a two-part epoxy paint system.
- C. Stainless steel shall be cleaned with mild abrasive wheels and/or nonferrous blast media to remove heavy scale and welding carbon and/or passivated with stainless steel cleaner then rinsed
- D. After surface preparation, ferrous metal surfaces, if any, except for the spiral flighting shall receive a minimum of one (1) coat of epoxy primer. Provide a total minimum dry film thickness of 3 mils prior to shipment to jobsite. Primer shall be compatible with the paint system specified for the

equipment under "Painting" section of these specifications. Finish coats shall be applied at the jobsite by the General Contractor, per Specification 09801 requirements.

1. The spiral shall be furnished with one coat of shop primer only.
2. Electric motors, gear reducers, electrical control panels, and other purchased sub-components shall be furnished with the manufacturer's standard finish.
3. Stainless steel surfaces do not require painting.

2.8 SPIRAL

- A. Spiral flighting for the shaftless screw conveyors shall be designed to convey material without a center shaft or hanger bearings.
- B. Spiral flights shall be cold-formed high strength chrome alloy steel with a minimum hardness of 225 Brinell. The spiral flights shall be designed with adequate stability to prevent distortion and jumping in the trough. A second, inner spiral, concentric with the outside spiral shall also be provided. The torsional rating of the auger flighting shall exceed the torque rating of the drive motor at 150% of its nameplate horsepower. The "spring effect" of the spiral shall not exceed + 1.0 mm per 100 mm of length at maximum load conditions. The minimum outer spiral thickness shall be 0.75" for spiral diameters up to 9" and 1" for spirals diameters exceeding 9".
- C. The spiral flighting shall be formed in sections from one continuous flat bar and shall be concentric to within ± 2 mm. Sectional flighting formed from plate shall not be permitted.
- D. Spiral flighting shall have full penetration welds at all splice connections. The flights shall be aligned to assure true alignment when assembled in the field and shall be made in accordance with the supplier's requirements. The spiral flights shall be coupled to the end shaft by a flanged, bolted connection.
- E. Sectional flighting made from flat plates will not be acceptable.

2.9 SPIRAL MOUNTING

- A. A gland packing ring consisting of two Teflon fiber packing rings shall seal the drive shaft at its penetration through the end plate, along with a greased labyrinth sealing system.
- B. The connection of the spiral to the drive system shall be through a flanged connection plate that is welded to the spiral forming a smooth and continuous transformation from the flange plate to the spiral. The drive shaft shall have a mating flange and shall be bolted to the spiral connection plate. Additionally, a grease lubricated labyrinth seal shall be shaft mounted internally in the conveyor between the back plate and spiral coupling connection.

2.10 HORIZONTAL AND INCLINED TROUGHS

- A. Troughs shall be U-shaped and similar to the dimensional standards of CEMA 350 and enclosure classification IIE.
 1. A flanged drain outlet shall be provided with each conveyor to facilitate cleaning if required by contract drawings. The drain outlet shall be piped to a drain as shown on the drawings, with adequate cleaning facilities. Drain flushing connections are to be provided if and where specified by the contract drawings. The Contractor shall furnish all labor and

materials to connect the conveyor flush water and/or drains with the plant water and drain system.

2. Each trough shall be equipped with inlet and/or discharge openings as shown on the contract drawings. If required, each inlet and discharge opening shall be flanged suitable for interconnection to other devices. Any interconnecting devices such as chutes and hoppers shall be fabricated from the same grade of material as the troughs and with a gauge thickness to suit the application requirements.

- B. Bolted covers shall be furnished for any portion of each trough that is not covered by the filling chute. Covers shall be manufactured in maximum five (5) foot length section to allow for easy access and ease of liner replacement. To prevent unsafe access to the conveyors, quick opening covers will not be allowed unless they are equipped with cover sensor to prevent access during operation. Each conveyor shall be fixed with the appropriate warning labels to call for lock out – tag out of the electrical system before the covers are removed. If required, inspection hatches or sample ports with finger guards will be supplied as indicated on the contract drawings.
- C. In order to avoid excessive wear and increased maintenance the conveyors shall be designed without the use of steel hold down bars. Proprietary hold-down guide liners mounted under the lids will be accepted that do not interfere with the flow of conveyed product.
- D. The conveyor system Manufacturer shall design Conveyor CNV-04 and supports to be self-supporting at the span to supports interior of the Sludge Processing Building and Sludge Loadout Building. The beams or truss-like structure supporting the conveyor at the span between the buildings and shall be designed and mounted to the conveyor to maximize clearance beneath the conveyor and shall not prevent conveyor access for inspection or liner replacement.

2.11 WEAR LINERS

- A. Liner - The inside trough surfaces of the conveyors shall be lined with a layer of ultra-high molecular weight polyethylene UHMW-PE. The wear liner shall be SPIRAC Duraflo SPX or Xylethon by Durawear. The liner shall be a single piece, formed and bonded with two (2) layers of the same material, each of a different color, to provide a visible indication when the liner is nearing the end of its useful life. Liners with a second layer of different material are not acceptable. The liner shall be supplied in maximum 3.3-foot long sections to provide ease of replacement. The liner shall be held in place with stainless steel clips; no fasteners will be allowed. Liner thickness shall be at a minimum 3/8" for vertical conveyors; 1/2" thick for spirals up to 14" diameter, and 5/8" thick for larger spirals. Liners less than the specified minimum thickness and molecular weight shall not be acceptable.

- B. The liner material shall have the following physical properties, as a minimum:

Property	Value/Unit	Testing Method
Density	61.2 lbs/ft ³	DIN53479
Molecular Weight	9.2x10 ⁶ g/mol	Margolies
Ball Indentation Hardness	5,946 lbs/in ²	DIN53456
Shore Hardness D	64	DIN53505
Crystalline Melting Range	278° F	-
Dynamic Coefficient of friction	0.1-0.12 ratio of tension/load	Plastic to steel

2.12 CONVEYOR SUPPORTS

- A. Each conveyor shall be furnished complete with supports suitable for mounting as shown on the contract drawings and as required by the supplier's design of 304 stainless steel structural angle,

minimum 0.25" thick. The supports shall be shop fabricated from stainless steel shapes and plates and shall be assembled and fitted to the conveyor prior to its delivery to the jobsite. Supports and conveyor segments shall be match marked and shipped to the jobsite for assembly and installation by the Contractor. The manufacturer shall allow for 1 inch of grout beneath each support foot pad for the Contractor to compensate for uneven floor elevation. At a minimum, each conveyor shall be provided with supports at the inlet and discharge end, with intermediate supports as required.

- B. All shop welding shall conform to the latest standards of the American Welding Society (AWS). The supports shall be designed to avoid interference with other equipment or equipment supports.
- C. All hanging supports furnished by the conveyor manufacturer shall be one (1) foot longer than required for field fit by the Contractor, who shall supply connections approved by the Engineer. The Contractor shall be responsible for all fasteners both for hanging and floor anchors.

2.13 HOPPERS, DISCHARGE CHUTES AND GATES

- A. Furnish inlet and discharge hoppers of the same gauge and construction material as the conveyor troughs, at locations as shown on the drawings. Flanges shall be a minimum 5 mm thick.
 - 1. A 10-gauge galvanized steel chute shall be located at the discharge end of the conveyor to direct the flow of material from the conveyor to the desired destination. The chute shall be designed so as to prevent the build-up of material on its interior surfaces.

2.14 TROUGH HEATING AND INSULATION

- A. Conveyor trough Insulation and heating
 - 1. Maintain material inside the screw conveyor trough above 45°F utilizing EHT cable.
 - a. EHT cable should be high power retention self-regulating RAYCHEM HTV cable. Voltage is 208V.
 - b. Controller shall be nVent RAYCHEM Elexant 4010i Series, rated up to 277V, Type 4X, IP64 (FRP enclosure), touch screen based, single point with ground fault protection. Temperature sensor shall be a 100-ohm, platinum RTD.
 - c. Secure the EHT cable to the outside of the trough using adhesive tape 2-3" x 180', Aluminum, Temp limit 550°F.
 - d. EHT Cable Junction box shall be non-metallic, NEMA 4X.
 - 2. Insulation and Jackets
 - a. Outer Jacket is required as a weather barrier to protect the insulation and EHT cable.
 - b. General: ASTM C 921, Type 1, except as otherwise indicated.
 - c. Aluminum Jacket: ASTM B 209, 3003 Alloy, H-14 temper, roll stock ready for shop or field cutting and forming to required sizes.
 - d. Finish and Thickness: Stucco Embossed finish, 0.016 inch thick.
 - e. Moisture Barrier: 1-mil, heat-bonded polyethylene and kraft paper.
 - f. Insulation material shall be Mineral Wool 1.5" board.
 - g. Provide stainless steel bands to secure jacketing and to support maintenance of the equipment.

2.15 SPARE PARTS

- A. Furnish the following spare parts (if applicable to scope of supply) as a minimum:

1. One (1) Packing gland set, for each conveyor supplied.
- B. All spare parts shall be boxed in substantial wooden crates for storage.

2.16 LUBRICANTS

- A. Furnish lubricants of the type and quantity as recommended by the conveyor manufacturer for (start-up) operation.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. The conveyor shall be delivered by the Manufacturer in fully assembled and complete with hardware and instructions, with exception to the spiral splices. Assembly shall consist only of joining the sections anchoring the supports, installing the bolt, and electrical hookup.
- B. Install equipment in accordance with reviewed Shop Drawings, and manufacturer's instructions, as specified herein and shown on Contract Drawings.
- C. Initial lubrication required for start-up and field test operation shall be furnished and applied in accordance with the manufacturer's recommendations.

3.2 FIELD QUALITY CONTROL

- A. The conveyor system supplier shall furnish the services at site of a factory-trained representative for a period of two (2) days in no more than one (1) trip to the jobsite. Service shall be provided as necessary after the Contractor has installed the equipment. These services shall be furnished for the purposes of:
 1. The equipment manufacturer's inspection of the equipment following installation by others, and to certify that the equipment has been properly installed and is ready to operate, to train the Owner's personnel in the operation, maintenance of the equipment, and to observe and supervise the initial operation of the equipment.
 2. If additional service is required due to the mechanisms not being fully operational, at the time of service requested by the contractor, the additional service days will be at the contractor's expense.
 3. For the purposes of this section, a work-day is defined as an eight hour period at the Site, excluding travel time.
- B. After inspection of the installed equipment the Supplier shall furnish a written report certifying that the equipment has been properly installed and lubricated, is in accurate alignment, is free from any undue stress imposed by connecting piping or anchorage, has been operated under full load conditions and that it operates satisfactorily.

3.3 DEMONSTRATION AND INSTRUCTIONS

- A. Provide the services of a qualified factory-trained manufacturer's representative to conduct training covering operation, mechanical maintenance and electrical requirements.

3.4 SHAFTLESS SCREW CONVEYOR SCHEDULE

SCHEDULE 461211 – A

Location	Sludge Dewatering Building	
Type	Horizontal	Incline
Trough length	As shown on the Drawings	As shown on the Drawings
Inlet QTY	1	1
Outlet Qty	1	1
Trough Material & Thickness	304 SS, 10 ga	304 SS, 10 ga
Lid Material & Thickness	304 SS, 12 ga	304 SS, 12 ga
Lid Type / Length	Bolted / 5ft max	Bolted / 5ft max
Liner Type	UHMW-PE	UHMW-PE
Liner Thickness	3/8 in	3/8 in
Conveyor Length	As shown on the Drawings	As shown on the Drawings
Angle of Inclination	As shown on the Drawings	As shown on the Drawings
Vol. Flowrate (ft ³ /hr) (lbs/hr)	113 7100	113 7100
Spiral Type	AB	AB
Spiral Material	HTMAS	HTMAS
RPM	To Be Provided	To Be Provided
Drive Type	Helical Gear	Helical Gear
Max. Motor hp	3	3
Power Supply	460V / 3ph / 60 Hz	460V / 3ph / 60 Hz
Transport Direction	Push	Pull
Insulation & Heat Tracing	No	Yes

END OF SECTION 461211

SECTION 462116 – MECHANICALLY CLEANED BAR SCREEN, WASHER COMPACTOR AND SHAFTLESS SCREW CONVEYOR

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.
- B. This section contains references to the following documents:
 - 1. American National Standards Institute (ANSI)
 - 2. American Society of Testing and Materials (ASTM)
 - 3. American Iron and Steel Institute (AISI)
 - 4. American Welding Society (AWS)
 - 5. American Institute of Steel Construction (AISC)
 - 6. American Bearing Manufacturers Association (ABMA)
 - 7. American Gear Manufacturers Association (AGMA)
 - 8. National Electrical Manufacturers Association (NEMA)
 - 9. Underwriters Laboratory (UL).
 - 10. National Electrical Code (NEC)

1.2 DESCRIPTION OF WORK

- A. This section includes the furnishing and installation of two (2) front-cleaning, front-return link driven mechanically cleaned bar screen assemblies, two (2) discharge chutes from the screen to the horizontal conveyor, one (1) horizontal screw conveyor to the washer compactor, and one (1) dual auger washer compactor unit, one (1) chute from the horizontal conveyor to the washer compactor, and one (1) discharge chute from the washer compactor to a dumpster, main and local control system and associated equipment complete and in place ready for service as shown on the drawings and described in this section.
- B. The mechanical bar screen, horizontal conveyor and washer/compactor unit shall be furnished as complete package system including the stainless steel frame, deck supports for the screen and washer/compactor as required, electric motors, gearbox, control package and instrumentation. All internal wiring, piping, valves, and control devices integrated into the equipment shall be delivered as part of the assembly. The mechanical bar screens shall be designed to positively clean and remove debris up to 1/4 inches in diameter from the influent stream by means of high impact plastic filter elements designed to retain and elevate debris to the discharge point of the unit where the rotating brush assembly cleans the elements.
- C. Electrical/control panels shall be completely assembled and ready for installation.
- D. The equipment furnished shall positively clean and remove debris from incoming sewage by means of a bar rack that retains the debris and scrapers/stagers that removes and elevates the debris, which has been retained. The bar screen shall be front cleaning, with scrapers/stagers engaging the bar rack from the upstream side of the rack.

- E. The mechanically cleaned bar screen shall be designed so that there are no chains, sprockets, bearings, shafting, or other moving parts permanently below the maximum water surface in the channel. All maintenance to the mechanism shall be accomplished at the operating floor level.

1.3 QUALITY ASSURANCE

- A. All equipment and components shall be furnished as complete standard type assemblies in accordance with the standards of the industry.
- B. All equipment furnished under this section shall be of a single manufacturer who has been regularly engaged in the design and manufacture of the specified equipment.
- C. All equipment furnished under this section shall be of a single manufacturer who has been regularly engaged in the design and manufacture of the specified equipment.
- D. Manufacturer shall have a minimum of ten (10) years' experience producing equipment substantially similar to that required and shall be able to submit documentation of at least fifteen (15) independent installations using the same size or larger equipment. Each installation must have been in satisfactory operation for at least five (5) years.
- E. The equipment furnished shall be fabricated, assembled, installed, and placed in proper operation condition in full conformity with approved drawings, specifications, engineering data, and/or recommendations furnished by the equipment manufacturer. The equipment manufacturer shall, in addition to the Contractor, assume the responsibility for proper installation and functioning of the equipment.
- F. In addition to requirements of these specifications, comply with manufacturer's instructions and recommendations for work. All equipment shall perform as specified and accessories shall be provided as required for satisfactory operation.

1.4 SUBMITTALS

- A. Submit manufacturer's technical data and application instructions per Section 013323.
- B. Product Data: Submit manufacturer's technical data and application instructions.
- C. Shop Drawings: The Contractor shall submit complete shop drawings of all equipment furnished for this project as covered by these specifications. All shop drawings shall clearly identify the specific equipment and material being supplied, the quantity being supplied, and all accessories, dimensions, descriptions, dimensional/orientation layout drawings, mounting and connection details, electrical control diagrams, wiring schematics and any other information required of the Engineer/Owner to determine compliance with the plans and specifications. The submittal as a minimum shall include the above data drawings and other related materials. The shop drawings shall be reviewed by the Contractor for completeness and compliance with the project and so acknowledge prior to the review by the Engineer.
- D. Shop Drawings: Submit for review the following:
 - 1. Dimensional drawings depicting all mechanical and electrical equipment dimensions and required overhead clearances.

2. Equipment layout, principal dimensions with related verifications required for installation including anchorage location.
3. Details on connectors for solids discharge chutes.
4. Equipment weight
5. Electrical control drawings
6. Drive motor data
7. A list of recommended Spare Parts including any Special Tools required for routine maintenance of the equipment.
8. Certified copies of performance shop test data and reports shall be supplied for approval before shipment from the factory.

E. Operation and Maintenance (O&M) manuals shall describe the theory of screening system, start-up, optimization, and maintenance operations for the equipment furnished and installed under this Section. The final O & M manuals shall be provided in digital format after equipment start-up in the close-out submittal process. The O & M manuals shall meet the requirements of Sections 01060 and 01097, including the following additional information:

1. As-Build Drawings of the Mechanical Cleaned Bar Screen Arrangement
2. Electrical diagrams
3. Controls and Accessories
4. Explanation of operating safety considerations
5. Repair Parts and maintenance materials
6. Troubleshooting data
7. Repair data

F. Warranty: The Equipment Manufacturer shall submit a warranty certificate for review. The date of the warranty begins after commissioning and operational demonstration and will be determined in the field by the Owner's Engineer.

1.5 WARRANTY

- A. The manufacturer shall guarantee all equipment furnished under this specification to be free from defects in material and workmanship for a period of one (1) year from the date of substantial completion. Any defects found within the warranty period shall be replaced if damaged or defective in the normal use of the equipment at no cost to the Owner.
- B. Manufacturer shall warrant for the period of 5 years all rotating parts of the Mechanically Cleaned Bar Screen including the gear motor, bearing, drive head, and the link system including the links, castings, pins and retaining rings. Manufacturer warrants that these components shall be replaced if damaged or defective in the normal use of the equipment.

1.6 DELIVERY, STORAGE AND HANDLING

- A. Comply with Section 01043, Product Handling and Protection.
- B. Equipment shall be shipped and delivered fully assembled, except where partial disassembly is required to conform to transportation regulations or for the protection of components.
- C. Handling, delivery, and storage of the equipment shall be in accordance with the Manufacturer's recommendations. No extra cost shall be charged the Owner for the handling, delivery, or storage of the equipment.

- D. Contractor shall be responsible for unloading and shall have equipment on-site at the time of delivery permitting proper hoisting of the equipment.
- E. Acceptance at Site:
 - 1. Inspect all equipment and materials against reviewed Shop Drawings at time of delivery.
 - 2. Equipment and materials damaged or not meeting the requirements of the reviewed Shop Drawings shall be immediately returned for replacement or repair.
 - 3. The Contractor shall notify the Manufacturer on any damages to equipment within 5 days to effect proper remedial action. Failure to notify the Manufacturer of damage to equipment prior to unloading shall void all warranties pertaining to subject equipment.
- F. Storage and Protection: Store all equipment and materials in a dry, covered, ventilated location and protect from harm according to the manufacturer's instructions. Carefully prepare for storage and label all equipment and materials after they have been inspected.

1.7 SEQUENCING

- A. Comply with Section 011100, Summary of Work.
- B. The Contractor shall take special note that the City of Sunbury WWTP must always remain in operation unless outages are approved by the Owner.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. The mechanical bar screens shall be in compliance with these specifications and plans and shall be supplied by the following manufacturer:
 - 1. FlexRake by Duperon Corporation, rated capacity at 6 MGD.
 - 2. Or Engineer approved equal.
- B. Washer Compactor
 - 1. WC3.D1.5, 304 SSSL by Duperon Corporation
 - 2. OR Engineer approved equal.
- C. Screw Conveyor
 - 1. DSSC, 304 SSSL
 - 2. Or Engineer approved equal.
- D. The design and layout shown on the drawings are based on FlexRake by Duperon Corporation. Other named or approved equals may differ with respect to the structure, electrical power, or controls. Changes in the structural, electrical, mechanical and plumbing requirements for the substitution shall be the responsibility of the CONTRACTOR wishing to make the substitution.

2.2 EQUIPMENT DESCRIPTION

- A. Design Conditions:

Bar Screens:

Bar Screen Quantity:	2
Average Day Design Flow, each	2 MGD
Peak Flow, each	6 MGD
Maximum Headloss at Peak Flow	2.83 inch
Downstream Water Level	950.82
Channel Depth:	3'-0" (to be verified by Contractor)
Channel Width:	3'-6" (to be verified by Contractor)
Bar Opening Size:	1/4 inch
Opening Type	Tear drop bar screen, SSTL316 0.25 inch x 0.75 inch x 0.13 inch
Angle of Installation	30-deg from vertical
Screen weight	4200 lbs
Discharge height into washer compactor	± 4.33 ft above operating floor
Screen nominal length	13 ft
Overall Screen Height from channel invert to Operating Floor	3.33 ft
Overall Screen Height from channel invert to Operating Floor	12 ft
Equipment Location	Indoors
Controls	Upstream Ultrasonic Level Sensors
Debris Bin	No, by Owner
Drive	1/2 HP, 460 Volts, Class I, Division 2, Group D Environment.

B. Washer Compactor

1. All components of the assembly shall be engineered for long, continuous, and uninterrupted service. Provisions shall be made for easy lubrication, adjustment or replacement of all parts.
2. Design Parameters:
 - a. Number of washer/compactors: 1
 - b. Type: Dual Auger
 - c. Avg. Capacity 15 cf/hr
 - d. Peak Capacity 30 cf/hr
 - e. Diameter of augers 8 Inches
 - f. Diameter of shafts 2 inches, Schedule 40 SS
 - g. Flights Min. 1/4-inch thick and 4-inch pitch
 - h. Min Drive Size 1 HP, VFD, rated for a Class I, Division 2, Group D Environment.
 - i. Power Requirements 3 Ph., 240/480 V, 60 Hz.
 - j. Compactor discharge height above grade: min 12-inches and max 18-inches
 - k. Wash water per compactor: 3-10 gpm @ 40-60 psi
 - l. Hopper Height (deck to hopper): 3.15 ft
 - m. Hopper Length: 3.56 ft
 - n. Discharge chute: 6 ft long, attached directly to washer compactor discharge chute. (to be verified by Contractor).
3. The screenings washing/compactor shall be sized to handle the peak washings from the mechanical bar screens.

4. Accepts variable debris up to four inches, including rocks, clothing, concrete, metal, grease and septage – eliminating jams and equipment shutdown.
5. Positive displacement technology shall assure that all debris which enters the hopper are washed, compacted and discharged for disposal.
6. Washer Compactor performance:
 - a. Reduced odor: The screenings washer/compactor shall discharge screenings with a minimum 30 percent and up to 60% dry solids and less than 5 percent free organic content; up to 60 percent mass/weight reduction.
 - b. Reduced landfill cost: Up to 84% volume reduction. Self-regulating compaction housing shall allow for consistent dry solids output regardless of fluctuations in debris volume.

C. Shaftless Screw Conveyor

1. The Shaftless Screw Conveyor shall have a single shaftless screw to provide positive movement action. Screw to rotate from a stop at 150% of operating load and handle peak loading of 150% of design load without damage or a decrease in service life.
2. Design Conditions

Peak Capacity:	50 cu.ft./hr
Trough width:	17.5 inch
Length:	10± ft , Contractor to field verify
Screw:	11.5" diameter 8620 alloy, Tnemec coated
Materials of Construction:	304 SSSL 8620 Alloy bar steel UHMW Screw Supports / Trough Liner
Inlet Height (Deck to Hopper):	36"
Performance Data	Typical Wastewater Debris
Start-up:	150% of max capacity
Design Capacity	150% of max capacity for peak loads without damage or reduced life
Motor Size:	1 hp
Motor Service Factor (Minimum):	1.0
Output Speed:	Min: 2.4 rpm Max: 9.8 rpm
Speed Reducer Ratio/Output:	179:1
Speed Reducer Paint:	Duperon® Standard Tnemec Coating
Phase/Voltage:	240/480 volt, 3 ph, 60 Hz

2.3 EQUIPMENT

A. Mechanically Cleaned Bar Screen

1. The mechanically cleaned bar screen shall have a head sprocket only, with no sprockets or similar drive components under water to trap the chain. Equipment utilizing reciprocating rake arms or sprockets below the water is not acceptable.
2. The mechanically cleaned bar screen shall run continuously without an operator.
3. The equipment shall have multiple scrapers on the bar screen at one time, cleaning continuously, from bottom to top, the entire width of the scraper. The drive output shaft rotation shall be constant and in one direction to reduce maintenance. Units which have single raking arms, or that require cycle times shall not be allowed. Cleaning mechanisms

that utilize shock absorbers, springs, or other dampening or hydraulic actuations are unacceptable.

4. The link system shall have jam evasion capability by flexing around and collecting large objects such as a 2 x 4's, bowling balls, grease balls and surges of solids at peak loading times without overloading and shutting down the unit.
5. The design shall be such to ensure that all maintenance can be accomplished at the operating floor level or above. No part of the drive system including sprockets shall be located below the water surface at maximum design flow.

B. Washer Compactor

1. Compaction Action: Dual augers shall provide positive displacement action and shall be orientated on top of each other, rotating in opposing directions. The augers are intermeshed and are of 1 left hand and 1 right hand lead and shall have ability to rotate, 2.2 RPM in opposing directions. Compactor augers shall be designed with a limited float on top of a perforated plate, allowing them to accommodate irregular debris.
2. Washing Action: Wash port manifold is integrated prior to the compaction housing and delivers 3 to 10 GPM assuming supply pressure is 40 to 60 PSI at 1/2-inch NPT connection for attaching water source utilizing filtered effluent or municipal water. Washing action is flood wash type from a single 1/2-inch NPT supply. Drain connection shall be 3" NPT male.
3. Operation: Washer Compactor is designed to be continuous run not requiring operator. Washer Compactor is equipped with a self-regulating, active pressure zone designed to accept non-standard wastewater debris in its original form, such as rocks, broken concrete, and metal (bolts, short pipe, etc.) up to 4 inches long. Washer Compactor shall have the ability to process multiple pieces of clothing, variable volumes of debris, and unprocessed septage or grease. Compactor moves at normal operating speed of 2.2 RPM and can run intermittently to sync with upstream equipment.

C. Shaftless Screw Conveyor

1. The Shaftless Screw Conveyor shall be continuous run, not requiring an operator. The Shaftless Screw Conveyor shall be equipped with a non-contacting, proximity-type speed switch on each conveyor for detecting zero speed condition on monitored equipment consisting of a sensor/pre-amplifier and an amplifier/output switch unit. The Shaftless Screw Conveyor shall have the ability to convey multiple pieces of clothing, variable volumes of debris, and unprocessed septage or grease. The Shaftless Screw Conveyor shall move at a normal operating speed of 2.4 to 9.8 RPM and shall have the ability to run intermittently to sync with upstream equipment.

2.4 MATERIAL OF CONSTRUCTION

A. Only corrosion resistant materials shall be used in components traveling underwater.

1. Materials and components described herein as "Stainless Steel" or "SSTL" shall be AISI 304 Stainless Steel unless specifically noted otherwise.
2. Materials and components described herein as UV stabilized UHMW-PE (Ultra High Molecular Weight Polyethylene) shall be per ASTM D4020-81 unless specifically noted otherwise.

Scrapers	UV Stabilized UHMW
Side fabrications, dead plate and cross members	SSTL304
Enclosure access panels	SSTL304

Screen deck supports	SSTL304
FlexLinks	SSTL304
Drive Head	SSTL304
Drive Sprockets and end castings	SSTL304
Drive Shaft	SSTL304
Screen Discharge chute	SSTL304
Hopper washer/compactor	SSTL304
Auger Shafts	SSTL304
Conveyor main housing	SSTL304
Trough Liners	UHMW

B. Fabrication Standards

1. Fabrications: All welded fabrications are to be made from stainless steel
2. All welders and all welding procedures shall be per AWS D1.6. and/or AWS D1.3.
3. All fasteners shall meet ASTM F593-86a.

C. Select Parts: Select power transmission parts to be made from cast iron and shall conform to coating as described in this specification, section for "SHOP PAINTING" below.

2.5 COMPONENTS

A. Mechanical Bar Screen:

1. The bar screen assembly shall be of stainless steel, bars shall be 316 stainless steel and be tear shaped with minimum dimensions of 0.25" x 0.75" x 0.13". Bar screen assembly shall adhere to Existing Conditions table criteria in relation to slot opening, angle of installation, channel dimensions, etc. Bars shall be spaced to maintain specified clear opening and withstand minimum 1 foot head differential. Bars shall be individually replaceable without welding. Bar screen assembly shall be shipped in one piece.
2. Channel Bottom Plate: A stainless steel channel bottom plate shall be an integral part of the bar screen to fully engage scrapers in the bar screen at the base of the unit and assure that the raking mechanism reaches the bottom of the screen to prevent debris accumulation.
3. Side Fabrication: The screen framework shall be stainless steel bent plate, with a minimum thickness of 0.25", and horizontal members shall be of stainless bent plate or pipe.
4. Return Guide/Closeouts: Return guide/Closeouts shall be 304 stainless steel and shall assure proper alignment of scrapers as they enter the bar screen and assure that there is no space wider than the clear opening between the bars, to prevent passage of larger solids, than allowed through the screen. Closeouts are incorporated into the return guides as determined by the manufacturer.
5. Link Slides: Link slide assembly shall be constructed of UV Stable UHMW PE rollers, and 304 stainless steel supports and components.
6. Dead Plate: Dead plate shall be 0.25" thick stainless steel. The dead plate shall span the entire width of the unit and transition from bar screen to discharge point.
7. Discharge Chute: The discharge chute shall be 11ga. (0.12 inch) 304 stainless steel. The discharge chute shall be bolted to the dead plate and shall be designed to allow debris to be transferred from discharge point into the debris containment.
8. Debris Removal Blade: A SSTL and UV Stable UHMW-PE debris removal blade assembly shall be installed to assist in removing debris from the scrapers on the mechanically cleaned bar screen as recommended by the manufacturer.

9. Screen Enclosure: A14ga. #4 brushed satin finish 304 SSTL enclosure covering from deck to discharge shall be provided and installed to cover the screen above the operating deck level. Front Enclosure shall have removable panels for access to equipment. Removable panels shall be 16 ga. 304 SSTL and shall be provided with knurled knobs for "no tool required" access. Alignment notches shall be included to support repositioning of removable panels. The top of the Front enclosure shall include a knockout for a customer site option to install a 6-inch diameter pipe stub. Rear Enclosure shall have hinged removable doors and shall be secured with a lift-slide-latch handle. Rear removable door shall include an integral viewing door that shall be secured with a lift-slide-latch handle to provide access for a quick look inside.
10. Link System: The link system shall be passivated stainless steel castings and have a minimum ultimate strength of 60,000 lbs with a minimum cross section of 1.5 inches and weighing a minimum of 4.5 lbs each. Parts must meet ASTM A380 specification for surface finish. The link system shall be 304 stainless steel link system including 304 stainless steel retaining rings and pins.
11. Scrapers: Scrapers shall be spaced 21 inches apart. The scrapers move at no greater than 28 inches per minute at standard operating speed of 1/2 rpm. Staging Scrapers and Thru Bar Scrapers shall be 3:1 ratio or as per manufacturer recommendations. At least one scraper every 84 inches shall fully penetrate the bar screen, cleaning all three sides of the bars.
 - a. Staging Scrapers: Staging Scrapers shall be of 1-inch thick UV Stable UHMW-PE with a serrated edge. Staging scrapers shall be easily modified by the Owner if necessary to suit future changes in debris conditions.
 - b. Thru Bar Scrapers shall be a minimum 0.375-inch thick x 5 inches x screen width 304 stainless steel.
12. Drive Head
 - a. Drive Unit
 - 1) Each mechanically cleaned bar screen unit shall operate independently and will have its own drive unit and driven components.
 - 2) Drive sprockets and end castings shall be cast 304 stainless steel
 - 3) Drive shaft shall be 304 stainless steel.
 - 4) Gearbox shall be grease lubricated and designed for 5 years (or 20,000 hours of operation) between recommended clean and re-grease services.
 - 5) Gearbox shall be shaft-mounted, right angle type and include spiral bevel gearing. The output shaft speed shall be controlled by a vector type inverter. It shall have at least a 1.52 or greater service factor based on machine torque requirements.
 - 6) The motor shall be AC induction type, 3 phase, 230/460 volt, and mounted to the gear reducer. Motor shall be 1/2 hp, designed for 1800 RPMs base speed and rated for Class I, Division 2, Group D environment and for use with an inverter. Motor shall have a 4/1 speed range, EPNV enclosure, NEMA design B with a 56C frame size. Service factor shall be 1.0 or greater, Class F insulation and be optimized for IGBT type inverter. The motor shall be UL listed and designed for continuous operation.
 - 7) Motor shall have built in thermostat to protect from overheating that is to be field wired to corresponding terminal in control panel for motor overtemperature protection.
 - 8) Overload protection shall be provided by the VFD monitoring motor current.
 - b. Bearing shall be a non-lubricated no maintenance engineered polymer Thordon® or Vesconite® bearings. Bearing containing grease are not acceptable.

- c. Speed Reducer: Speed reducer shall be a double-reduction, cycloidal style and shall comply with all applicable AGMA standards. The speed reducer shall be capable of a 4/1 speed range with variable output speeds between 0.50 to 2.2 output RPMs (in high flow conditions). The speed reducer shall produce an output torque of 11,417 inch-lb and have a gear ratio of 809:1.

B. Washer Compactor

1. Compactor Housing: The compactor housing shall be constructed of stainless steel and be a minimum of 11 Gauge and connect to 3/8" flanges.
2. Augers: Shall be of stainless steel with flights 3/8 inch and have a 4-inch flight pitch. Augers shall float mounted in a UHMW thrust and plane bearing arrangement that allows flexibility around irregular debris to accommodate it.
3. Drive Assembly:
 - a. Each Washer Compactor unit shall operate independently and will have its own drive unit and driven components. The gearbox shall not be vented to the outside atmosphere.
 - b. The gearbox shall be grease lubricated and designed for a 5 yr (or 20,000 hours of operation) between recommended clean and re-grease services. The gearbox shall be right angle type and shall incorporate cycloidal and spiral bevel gearing with a total ratio of 809:1. The gear reducer output shaft speed shall be approximately 0.5 RPM minimum – 2.2 RPM maximum and controlled by vector type inverter. It shall be shaft mounted utilizing the keyless Taper Grip® bushing.
 - c. The motor shall be mounted to the gear reducer by utilizing a quill, C-Face mounting style. The gearmotor shall be AC induction type, 1 HP, 3/60/230/460-volt, explosion proof, inverter duty model, and rated for a Class I, Division 2, Group D environment.
 - d. Overload protection shall be provided by the VFD monitoring motor current.
4. Speed Reducer: Shall have a maximum output of 2.2 rpm, 809:1 reduction ratio with 18,940 in-lb of output torque.
5. Thrust Bearings: Shall be Derlin or equivalent, self-lubricating and be capable of withstanding 2000 lbf of thrust load (each auger) at 2.2 RPM for life of machine.
6. Upper and Lower Screw Supports: Shall be UHMW plane type, self-lubricating and fastened into place using stainless steel fasteners.
7. Screw supports shall be UHMW plane type, self-lubricating and fastened into place using stainless steel fasteners.
8. Spur Gears: Shall be 17-4 PH stainless steel.

C. Shaftless Screw Conveyor

1. Trough: The trough of the Shaftless Screw Conveyor shall be constructed of stainless steel (material options contained in table) with a minimum thickness of 10 gauge. Single welded pieces up to 12 feet. Longer troughs shall be construction of two (2) or more sections connected by bolted joining flanges. Flange connections shall be 3/8 inch. Joints to have a minimum 1/8" thick self-adhesive neoprene gasket over the full face of the flange.
2. Inlet(s)/Outlet(s): The Inlet(s) and Outlet(s) of the Shaftless Screw Conveyor shall be constructed of stainless steel (material options contained in table) with a minimum thickness of 12 gauge.
3. Spiral: The spiral shall be of cold formed in a continuous process from a minimum of 20' long bar sections with a minimum of 300 BHN and tensile strength of at least 120,000 psi (material contained in table). Spiral to be 11.5 inch diameter flights, 0.75 inch thick minimum, with 12 inch flight pitch. The spiral shall be coupled to a transmission at the drive end and be supported at the outlet end with UHMW hold down bearing. Spiral to be

- complete with flanged end with mating bolt holes to the flange welded to a 2 inch solid stainless steel stub shaft.
4. Trough Liner(s): The trough liners of the Shaftless Screw Conveyor shall be 1/2 inch minimum thick UHMW (material contained in table) and shall be pre-formed to a permanent "U" shape.
 5. Covers: The covers of the Shaftless Screw Conveyor shall be constructed of stainless steel (material options contained in table) with a minimum thickness of 12 gauge. Covers not to exceed 48 inches in length. Covers are to be attached to the trough flange using hex head bolts.
 6. Drain: The trough of the Shaftless Screw Conveyor to be complete with a stainless steel 4" NPT diameter drain nipple extending three (3) inches below the trough, located at the low point of the trough.
 7. Lubrication System: The bearings and packing gland of the Shaftless Screw Conveyor to be equipped with grease fittings and shall be lubed for startup upon shipment.
 8. Drive Assembly:
 - a. Each Shaftless Screw Conveyor unit shall operate independently, with its own drive unit and driven components. The gearbox shall not be vented to the outside atmosphere.
 - b. The gearbox shall be grease lubricated and designed for 5 years (or 20,000 hours of operation) between recommended clean and re-grease services. The gearbox shall be right angle type and shall incorporate cycloidal and spiral bevel gearing with a total ratio of 179:1. The gear reducer output shaft speed shall be 2.4 RPM minimum to 9.8 RPM maximum and controlled by a vector-type inverter (or greater service factor) based on unit torque requirements. It shall be shaft-mounted utilizing the keyless Taper-Grip® bushing.
 - c. The motor shall be mounted to the gear reducer by utilizing a quill, C-Face mounting style. The motor shall be AC induction type, 1 HP, 3/60/230/460 volt, explosion-proof, inverter-duty model.
 - d. The drive assembly shall incorporate the Duperon® standard coating system.
 9. Transmission:
 - a. Adjustable packing gland seal shall be provided where drive shaft project through conveyor end plate. Packing glands to be complete with not less than three packing rings per stuffing box where sealing is critical and as determined by the Manufacturer. Provide grease fitting to lubricate the packing rings.
 - b. Fit each gear motor support with a grease nipple, with escape release provisions.
 10. Speed Reducer: The Speed Reducer of the Shaftless Screw Conveyor shall have a maximum output of 9.7 RPM, 179:1 reduction ratio with 6,000 in-lb. of output torque.
 11. Screw Hold down: Screw hold downs of the Shaftless Screw Conveyor shall be UHMW and bolted to the sides of the trough.

2.6 ELECTRICAL, CONTROLS, AND INSTRUMENTATION

A. Mechanical Bar Screen, Washer Compactor and Shaftless Screw Conveyor Control Package:

1. Controls shall be provided by bar screen manufacturer and shall be a standard VFD package with control based on upstream levels.
2. Controls shall be provided by the Screen and Washer Compactor manufacturer and shall be integrated into a single control panel and shall be located in a dedicated non-hazardous electrical equipment room.
3. The Main Control Panel shall be rated NEMA 12.

4. Controls shall be designed to accept 3PH/480VAC incoming power supply per plans/specs. Control panel power shall be 1PH/120VAC and shall include a step-down transformer as needed to achieve 120V.
5. Controls shall be built by a UL approved panel builder and bear the UL approved logo. Controls shall be tested by panel builder and by the rake manufacturer prior to shipment to Owner. The rake manufacturer shall verify all overload settings in the rake controller to ensure proper overload and speed settings required for the application are properly programmed.
6. Controls shall have an inner door pocket that includes a copy of as-built drawings from the manufacturer as well as any other pertinent documentation necessary to properly operate the controls. As-built drawings bearing the manufacturer's title block shall be included in the O&M manual and delivered 4-6 weeks after equipment shipment or sooner electronically as required by the Owner.

B. Mechanical Bar Screen Controls

1. Main Panel: The controls shall be located separate from the mechanical bar screen room and be mounted per manufacturer's requirements.
2. The rake controls shall operate manually in Hand mode and enable the Forward and Jog Reverse buttons on the push button station. When the rake HOA is in Auto mode, the rake shall be controlled by the rake controller.
 - a. The rake controller shall include a control program that automatically accelerates/decelerates the rake as the upstream water level increases/decreases, respectively. The water level values (setting parameters) shall be field adjustable for rake run point and each acceleration set point.
 - b. The controller program shall also have cycle timing logic, which shall have field adjustable run and stand-by times.
 - c. The rake shall start operation in Auto mode whenever a call to run is received by upstream water level elevation, timer or by a dry contact input from another source, which all run in parallel.
3. The "VFD Fault" shall be cleared by turning the respective HOA switch to Off, then waiting approximately three minutes (or per current UL standards), then turning the respective HOA switch back to the desired setting. To avoid the wait period, the VFD Fault can be reset using the disconnect switch, or otherwise cutting power to the VFD. The motor overtemperature (overtemp.) faults shall clear automatically when the motor cools to be within normal operating range.
4. The control package shall include the following and utilize the panel builder's standard component manufacturers, unless otherwise approved by the rake manufacturer:
 - a. NEMA12, enclosure with continuous hinge, exterior, lockable door.
 - b. HOA Selectors for each piece of equipment, where Hand mode enables the Forward and Jog Reverse pushbuttons located on the corresponding remote push button station. Auto mode for the rake enables PLC logic (upstream level and cycle timing programs) and discrete remote start capabilities.
 - c. Variable Frequency Drive (VFD), preprogrammed for speed/overload control by the panel builder and verified by the rake manufacturer.
 - d. Rake controller with required upstream level elevation and field adjustable cycle timing programs. User-defined fields to be programmed during on-site start-up by the rake manufacturer per Owner specifications to maintain good flow conditions.
 - e. Dry contact input for motor thermostats to shut down equipment if motor overtemp condition occurs, allowing equipment to restart automatically once motor temp has returned within normal operating range.

- f. Dry contact output signals for each piece of equipment for "Run", "VFD Fault", "Motor Overtemp" and "In Auto" conditions.
 - g. 120VAC output for the shaftless screw conveyor and it shall be interlocked with the screen ON/OFF operation. The timer shall continue the conveyor running for predetermine off delay. Conveyor runs when either screen is running.
 - h. 120VAC output for washer/compactor "Start Solenoid", which is to be energized whenever washer/compactor is running, regardless if in Hand or Auto modes.
 - i. Dry contact input terminals for "Remote Run", "Motor Thermostat" and remote push button station operators.
 - j. Intrinsically safe barriers for transducer terminations.
 - k. Main control power breaker with lockable, thru-door operator.
 - l. Elapsed run-time meters.
 - m. Push-To-Test type indicator lights for both pieces of equipment for "Power On", "Forward", "VFD Fault" and "Motor Overtemp".
 - n. Phenolic label on outer door indicating equipment I.D. number (as required by Owner).
 - o. Push/pull E-Stop on outside of enclosure.
 - p. PLC shall be capable of being integrated into the future plant SCADA system via control network utilizing Ethernet/IP protocol. Screen controller shall be compatible with Allen Bradley Compact Logix or Micro 800 family.
 - q. Provide an unmanaged Ethernet switch with spare port for future connection to the plant SCADA system. Data shall be available to be read from the PLC, reporting information relating to general system operation, and at minimum this data shall include the following statuses for each motor:
 - 1) Run
 - 2) VFD Fault
 - 3) In Auto
5. Local Control Station: NEMA 7 local push button station for each piece of equipment is required to maintain equipment and safety requirements pertaining to Class I, Division 2, Group D rated installation environments.
- a. The local stations for each piece of equipment shall include: Forward, Jog Reverse and E-Stop buttons. Each piece of equipment shall have its own local station. The local station(s) shall be mounted as close to the equipment as safely possible and be field wired by the electrical subcontractor to the corresponding terminal inputs in the main control panel.
6. One level transducer shall be installed upstream of each Bar Screen. The transducers shall connect to corresponding, intrinsically safe terminations in the main control panel and utilize the rake manufacturer's rake controller. The rake controller logic shall include (at a minimum) a level program with automatic speed ramping and reducing as the upstream water level increases and decreases respectively and a cycle timing program. The rake controller logic shall be capable of receiving signal from the transducer. The transducers shall be mounted in accordance with Manufacturer's recommendations. The cabling for the ultrasonic level transducers shall be 50-ft long and must not be spliced.
7. One mechanical float switch in each channel shall be provided and installed for backup to the upstream level control system.
8. The following shall be provided by the Electrical Contractor as needed and are not part of the bar screen manufacturer's scope of supply:
- a. Mounting stands
 - b. Mounting hardware
 - c. Field wiring & conduit

- d. Junction boxes
 - e. Installation
9. The field wiring shall be provided by the Electrical Contractor and shall include (but not be limited to) the following connections as applicable:
- a. Incoming power supply to the Main Control Panel.
 - b. All required grounding of the motor and the Main Control Panel.
 - c. Motor to the Main Control Panel.
 - d. Motor thermostat to the terminal inputs in the Main Control Panel.
 - e. Level transducers, floats, and all other required instrumentation to the corresponding terminal inputs in the Main Control Panel.
 - f. Input and output signal wiring for remote start/stop as required by plans/specs.
 - g. All remote station contacts to the corresponding terminal inputs in the Main Control Panel.

C. Washer Compactor Controls:

1. The controls shall enable the local push button station installed near the washer compactor when in "Hand" mode and utilize an input signal from a remote source when in "Auto" mode. Upon receiving a stop signal in "Auto" mode, the washer compactor shall utilize an off-delay timer to allow debris to finish depositing.
2. A VFD fault shall be cleared by turning off the equipment then waiting approximately three minutes (or per current UL standards) then turning the HOA back to the desired setting. A motor overtemp fault shall clear automatically when the motor cools to be within normal operating range.
3. The control package shall include the following and utilize the panel builder's standard component manufacturers, unless otherwise approved by the manufacturer:
 - a. HOA Selector where "Hand" mode shall enable the local station and "Auto" receives a Run signal from a remote/discrete source. When input signal is cut, the washer compactor shall then utilize an off-delay timer to allow debris to finish depositing.
 - b. VFD controller pre-programmed for speed/overload control by the panel builder and verified by the Washer Compactor manufacturer.
 - c. Dry contact input for motor thermostat to shut down equipment if motor overtemp condition occurs.
 - d. Dry contact output signals for "Run", "Start Solenoid", "Common Fault", "In Auto" conditions.
 - e. 120VAC output power to wash water solenoid.
 - f. Main control power breaker with lockable, thru-door operator.
 - g. Elapsed run-time meter.
 - h. Push-To-Test type indicator lights for "Power On", "Forward", "VFD Fault" and "Motor Overtemp".
 - i. Phenolic label on outer door indicating equipment I.D. number (as required by owner).
 - j. Push/pull E-Stop on outside of enclosure.
4. The Local Control Station shall be rated a NEMA 7 and include: Forward, Jog Reverse and E-Stop buttons. The remote station shall be mounted as close to the equipment as safely possible and be field wired by the electrical subcontractor to the corresponding terminal inputs in the main control panel.
5. The following shall be provided by the electrical contractor and are not part of the Washer Compactor manufacturer's scope of supply:
 - a. Mounting stands
 - b. Mounting hardware

- c. Field wiring & conduit
 - d. Junction boxes
 - e. Installation
6. The field wiring shall include (but not be limited to) the following connections as applicable:
- a. Incoming power supply to the main control panel
 - b. All required grounding of the motor and controls
 - c. Motor to the main control panel
 - d. Motor thermostat to the terminal inputs in the control panel
 - e. Input and output signal wiring for remote start/stop as required by plans/specs.
 - f. Local Control Station contacts to the corresponding terminal inputs in the main control panel.

D. Shaftless Screw Conveyor Controls

- 1. The Shaftless Screw Conveyor controls shall be integrated into the main control panel of the bar screen provided by the Screen Manufacturer.
- 2. Zero speed sensor shall be included by the manufacturer.
- 3. E-Stop pull cord shall be provided by the manufacturer.
- 4. Local Control Push Button Station:
- 5. The remote pushbutton station shall be provided by the manufacturer and shall include:
 - a. Enclosure shall be NEMA 7 rated for Classified area installation.
 - b. Forward, Jog Reverse and E-Stop buttons.

2.7 SHOP PAINTING

- A. All drive assembly made from cast iron or carbon steel components shall be coated in strict accordance with the paint manufacturer's specification. Surface Preparation shall be done in accordance with SSPC-SP-10 Near White. The three-part coating system shall be manufactured by Tnemec as follows: Prime Coat Series 90-97 Tnemec Zinc at 2.5-3.5 mils DFT, Intermediate Coat Series 27 F.C. Typoxy at 3.0-5.0 mils DFT, and Topcoat Series 1095 Endura-Shield II at 2.0-3.0 mils DFT. Standard color is 11SF Safety Blue. Material shall meet all state and federal VOC and other regulatory requirements.
- B. All non-stainless bar screen components shall be coated in strict accordance with the paint manufacturer's specification. Surface Preparation shall be done in accordance with SSPC-SP-10 Near White. The three-part coating system shall be manufactured by Tnemec as follows: Prime Coat Series 90-97 Tnemec Zinc at 2.5-3.5 mils DFT, Intermediate Coat Series 27 F.C. Typoxy at 3.0-5.0 mils DFT, and Topcoat Series 1095 Endura-Shield II at 2.0-3.0 mils DFT. Standard color is 11SF Safety Blue. Material shall meet all state and federal VOC and other regulatory requirements.

2.8 ACCESSORIES, SPECIALTY TOOLS, SPARE PARTS, AND LUBRICATION

A. Mechanical Bar Screen

- 1. Manufacturer shall provide any specialty tools and recommended spare parts required for maintaining the equipment as follows:
 - a. Ten (10) Snap/Retaining Rings
 - b. Four (4) Link Clevis Pin
 - c. Four (4) Scraper Nuts and Bolts
 - d. One (1) Snap Ring Tool

- e. One (1) Never Sees
- 2. Manufacturer shall provide a 5-year supply of lubrication required for maintaining all bar screen components.

B. Washer/Compactor

- 1. Spare Parts and Special Tools shall include a plane bearing kit consisting of:
 - a. Two (2) Upper/Lower Support: Auger
 - b. Two (2) Side Support: Auger
 - c. Twenty four (24) FHCS: 0.25-20x1
 - d. Twenty four (24) 0.25 Flat Washer SAE
 - e. Twenty four (24) 0.25 Nylock Nut
 - f. One (1) Anti Seize Lubricant
 - g. One (1) Grease Tube (14 oz)

C. Shaftless Screw Conveyor

- 1. One (1) Set of packing material.
- 2. 14 oz. grease tube.

PART 3 - EXECUTION

3.1 DELIVERY

- A. All equipment shall be shipped and delivered fully assembled, except where partial disassembly is required in order to conform to transportation regulations or for the protection of components.

3.2 INSTALLATION

- A. It is the intent of this Contract that the final installation shall be complete in all respects and the Contractor shall be responsible for minor details and any necessary special construction not specifically included in the drawings or specifications.
- B. Equipment shall be installed in strict conformance with the manufacturer's installation instructions, as submitted with Shop Drawings, Operation and Maintenance Manuals and/or any pre-installation checklists. Installation shall utilize standard torque values and be installed secure in position and neat in appearance. Installation shall include any site preparation tasks as required by the Engineer or Manufacturer; such as unloading, touch-up painting, etc. and any other installation tasks and materials such as wiring, conduit, controls stands as determined by the Owner and/or specified by the Manufacturer.
- C. Anchor Bolts: Anchors, anchor bolts, nuts and washers shall be 304 stainless steel and furnished for each item of equipment by the Contractor.
 - 1. Anchor bolt template drawings shall be included in the submittal to permit verification of the location structural elements, new or existing in the concrete.
 - 2. Equipment manufacturer shall specify ample size and strength required to securely anchor each item of equipment. Anchor bolt template drawings shall be included in the submittal to permit verification of the location structural elements, new or existing in the concrete.
 - 3. Bolts for FlexRake toes and plates: approximately twelve (12) 1/2" dia. x 4- 1/2" long Embed HAS Rods w/Hilti RE-500 SD Adhesive System.

4. Bolts for FlexRake Return Guide / Closeout: approximately fourteen (14) 3/8" dia. x 3-3/8" Lg. Embed HAS Rods with Hilti RE-500 SD Adhesive System.
 5. Anchor bolts shall be provided by the Contractor. Equipment shall be placed on the foundations, leveled, shimmed, bolted down, and grouted with a non-shrinking grout.
- D. Installation shall include site preparation tasks. Any support framing required to achieve proper alignment for installation and operation shall be SSSL 304.
- E. Plumbing connection is a standard 1/2-inch NPT pipe with male threads for connection to a non-potable water supply and a 3-inch female NPT for drainage. All plumbing is to be completed at site following all local and national plumbing regulations by a qualified individual.

3.3 TESTING

- A. After completion of the installation, the equipment shall be tested by the Contractor in the presence of the Engineer under actual operating conditions. The test shall be conducted under the supervision of the manufacturer's technical representative and shall demonstrate that the equipment is fully operational by picking up and depositing materials into specified containment.
- B. Field certification shall include inspection of the following:
1. Verify equipment is properly aligned and anchored per the installation instruction and drawings. Assure the bar screen unit is square, flat and unobstructed with required clearances maintained.
 2. Assure controls and instrumentation work in all modes.
 3. Check equipment for proper operation of debris blade, scrapers, etc. as well as completion of the Start-Up requirements in the installation guide.
- C. Testing of the washer compactor shall demonstrate that the equipment is operational, and that the equipment will wash, compact, and deposit materials in the designated dumpster.

3.4 MANUFACTURER'S SERVICES

- A. After completion of the installation, the equipment shall be tested by the Contractor in the presence of the Engineer under actual operating conditions. The test shall be conducted under the supervision of the manufacturer's technical representative. He shall provide a written report attesting that the units have been properly installed and placed into satisfactory operation.
- B. The manufacturer of the system shall provide a representative to check the installation, make final adjustments, supervise the initial startup of each mechanism, and prepare a written report thereof for the Owner.
- C. The equipment manufacturer shall provide service to include Installation Certification and shall include one (1) 8-hour man-day for startup service and one (1) 8-hour man-day (travel time excluded) for training session to instruct Owner's personnel in screen operation, electrical and mechanical maintenance. A minimum of 30 days' notice is required to schedule manufacturer's services.

3.5 LUBRICATION

- A. The equipment shall be lubricated by the Contractor when erected and he shall furnish the necessary oil and grease for one (1) year of operation. The grades of oil and grease shall be in accordance with the recommendations of the manufacturer.

3.6 OPERATION AND MAINTENANCE MANUALS

- A. Prior to or with the delivery of equipment, the manufacturer shall provide copies of an operation and maintenance manual including storage, installation, start-up, operating and maintenance instructions and a complete parts list and recommended spare parts list. The O & M manuals shall be in compliance with the General Requirements.

3.7 MANUFACTURER'S SERVICES

- A. Provide Manufacturer's certificate of installation and commissioning following functional testing and startup.
- B. The equipment manufacturer shall provide Instruction of Owner's Personnel per Section 017902.

END OF SECTION 462116

SECTION 462133 - AUTOMATIC BACKWASH DISCFILTER EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specifications sections, apply to work of this section.
- B. Applicable Standards:
 - 1. American Society for Testing and Materials (ASTM).
 - 2. American Iron and Steel Institute (AISI).
 - 3. American Bearing Manufacturers Association (ABMA).
 - 4. American Gear Manufacturer's Association (AGMA).
 - 5. National Electrical Manufacturer's Association (NEMA).
 - 6. National Fire Protection Association (NFPA).
 - 7. National Electric Code (NEC).
 - 8. Underwriters Laboratory (UL).

1.2 DESCRIPTION OF WORK

- A. Contractor to furnish all labor, materials, equipment and incidentals required for the automatic backwash filter system as shown on the Contract Drawings and as specified herein, installed, tested and ready for operation.
- B. Each Discfilter shall consist of a central drum onto which the filter media panels are assembled. The center drum shall be supported by sets of roller wheels or by two (2) sleeve bearings at opposite ends of the drum. Each filter unit shall include center drum with filter media panels, support frame with cover over the entire filter, backwash spray assembly with pump, backwash trough, and drive mechanism, automatic control system and components as specified.
- C. Filter shall be designed for installation as shown on the contract drawings/plans.
- D. It is the intent of this Contract that the final installation shall be complete in all respects and the Contractor shall be responsible to coordinate all details; coordination with trades; equipment manufacturing; installation and manufacturer's start-up services; and any necessary special construction not specifically included in the Drawings or Specifications.
- E. The disc filtration units shall be fully preassembled, and factory inspected prior to shipping the filtration units. Drive motor and backwash pump are to be installed at factory and provided integral to filtration unit.
- F. The valves, equipment, materials of construction and controls specified under this section supersede valves, equipment, materials of construction and controls specified elsewhere in the contract documents. Purchased components such as gear reducers, pumps, motors, valves, and actuators shall be provided as per filter manufacturer's standard designs and with standard recommended manufacturer's paint.

- G. The Manufacturer shall furnish the equipment complete in all details, ready for installation and operation. The Contractor shall properly install, adjust and place in operation the complete installation.
- H. The Contractor shall pay particular attention to elements of work requiring coordination with other trades and/or contractors. The Contractor shall coordinate all general trades work separately installed however related to the equipment; electrical, control and instrumentation components including verification of wiring, conduit, associated equipment and all shop drawings supplied the Contractor for the actual installation.
- I. The Contractor shall include in the lump sum price bid all associated cost for the Work. The Contractor shall assume full responsibility for additional costs which may result from unauthorized deviations from the Specifications.
- J. The contract drawings and specifications were prepared based on **Hydrotech Discfilter** as manufactured by Veolia, and the Contractor shall base bid on this equipment.

1.3 QUALITY ASSURANCE

- A. In addition to requirements of these specifications, comply with manufacturer's instructions and recommendations for work.
- B. Manufacturer shall have a minimum of twenty (20) years' experience producing equipment substantially similar to that required and shall be able to submit documentation of at least ten (10) independent installations using the same size or larger equipment. Each installation must have been in satisfactory operation for at least five (5) years.
- C. All equipment specified in this section shall be furnished by one manufacturer. To assure unity of responsibility, center drum or shaft, discs with filter media panels, support frame with cover over the entire filter, backwash spray assembly with pump, backwash trough, drive mechanism, automatic control system and components as specified shall be furnished and or coordinated by a single manufacturer.
- D. All equipment and components shall be furnished as complete standard type assemblies in accordance with the standards of the industry.
- E. All work performed under this section shall be in accordance with all approved trade practices and manufacturer's recommendations.
- F. The Contractor shall coordinate and verify the actual field conditions with that of the equipment being furnished prior to submittal of shop drawings. Any conditions of concern shall be noted on the shop drawings for the Engineers/Owners review.
- G. The Contractor shall provide confirmation from the manufacturer that the equipment being supplied meets the design conditions, conditions of service and overall system installation.
- H. Factory Testing: The automatic backwash Discfilter shall be fully assembled, and shop tested at the manufacturing facility prior to shipment. Testing shall adhere to manufacturer's standards. Manufacturer shall provide a certificate of completion of the factory testing to certify that the equipment was successfully assembled and satisfactorily operated prior to shipment.

- I. All equipment shall perform as specified and accessories shall be provided as required for satisfactory operation.

1.4 WARRANTY

- A. The Equipment shall materially conform to the description in this Specification and the Contract Documentation and shall be free from defects in material and workmanship. Warranty periods are 18 months from delivery or 1 year from beneficial use, whichever occurs first.

1.5 SUBMITTALS

- A. Product Data: Contractor shall submit manufacturer's technical data and application instruction in accordance with the General and Supplementary Conditions and Division 1 Specifications and any additional information listed herein.

- B. Shop Drawings: Submit for review the following:

1. Dimensional drawings depicting all mechanical and electrical equipment dimensions and required overhead clearances.
2. Equipment layout, principal dimensions with related verifications required for installation including anchorage location.
3. Details on connectors for solids discharge chutes.
4. Equipment weight
5. Electrical control drawings
6. Drive motor data
7. A list of recommended Spare Parts including any Special Tools required for routine maintenance of the equipment.
8. Certified copies of performance shop test data and reports shall be supplied for approval before shipment from the factory.

- C. Operation and Maintenance (O& M) manuals shall describe the theory of screening system, start-up, optimization and maintenance operations for the equipment furnished and installed under this Section. The final O & M manuals shall be provided in digital format after equipment start-up in the close-out submittal process. The O & M manuals shall meet the requirements of Section 017823, including the following additional information:

1. Drawings of the Automatic Backwash Discfilter Equipment
2. Electrical diagrams
3. Controls and Accessories
4. Explanation of operating safety considerations
5. Repair Parts and maintenance materials
6. Troubleshooting data
7. Repair data

- D. Warranty: The Equipment Manufacturer shall submit a warranty certificate for review.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Packing, Shipping, Handling and Unloading:
 - 1. Comply with Section 016600, Product Handling and Protection.
 - 2. The equipment shall be shipped in the largest assemblies possible permitted for transporting to minimize field assembly by the Contractor.
 - 3. Items delivered partially disassembled when required by transportation regulations, for protection of components or when field assembly is required, shall be shipped in the largest possible assembly to minimize field assembly in accordance with industrial standards and the manufacturer's recommendation.
- B. All internal wiring, piping, valves and control devices integrated into the equipment shall be delivered as part of the assembly. Equipment with motors shall be delivered on common base plates or equipment stands as recommended by the manufacturer. Electrical/control panels shall be completely assembled and ready for installation on stands provided by the equipment supplier. Items delivered partially disassembly when required by transportation regulations, for protection of components or when field assembly is required shall be shipped in the largest possible assembly to minimize field assembly in accordance with industrial standards and the manufacturer's recommendation.
- C. Equipment and materials damaged or not meeting the requirements of the reviewed Shop Drawings shall be immediately returned for replacement or repair.
- D. Carefully prepare for storage and label all equipment and materials after they have been inspected.
- E. Store all equipment and materials in a dry, covered, ventilated location and protect from harm according to the manufacturer's instructions.

1.7 PERFORMANCE REQUIREMENTS

- A. The Discfilter System consist of two (2) Discfilters and each shall be capable of meeting the performance requirements provided in the table below.

Performance Requirement	Units	Value
Influent		
Influent Source	N/A	Secondary Clarified Effluent following Activated Sludge
Peak Hour Flow Rate	MGD (gpm)	6.0 (4,167)
Average Day Flow Rate	MGD (gpm)	2.0 (1,389)
Peak Influent TSS	mg/L	≤ 45
Average Influent TSS	mg/L	≤ 30
Peak Influent TP	mg/L	≤ 1.0
Soluble non-reactive P	mg/L	< 0.02
Effluent		
Monthly Average Effluent TSS	mg/L	≤ 12
Monthly Average Effluent TP	mg/L	≤ 0.28 / ≤ 0.1 (Future)

1. Influent Peak TSS includes 15 mg/L solids generated from chemical addition and Influent Average TSS includes 10 mg/L solids generated from chemical addition.
2. Chemical co-precipitation may be required ahead of the secondary clarifiers to reduce soluble phosphorus prior to the filters. The chemical addition must be flow paced and optimized to limit residual reactive chemical. Direct dosing of metal salt and/or polymer into the piping preceding the filter is not recommended unless dosed in a location that provides adequate mixing and retention time in coordination with System Supplier's recommended guidelines.
3. Non-reactive phosphorus is defined as phosphorus compounds (mostly polyphosphate) that do not respond to colorimetric tests without preliminary acid hydrolysis (or oxidative digestion) of the sample and can occur in both dissolved and colloidal forms. For purposes of quantitative measurement, the non-reactive phosphorus concentration is defined as the difference between the effluent filtered Total Phosphorus and the effluent filtered reactive phosphorus (ortho-phosphate) concentrations.
4. Average TSS and TP concentrations are based on analysis of 24 hr flow proportioned composite samples.

B. Filter System General Design Information:

Filter design criteria such as pore size, filter material, number of discs per unit, filter disc diameter, effective surface area per unit and peak hydraulic loading rate shall be determined by the manufacturer to meet the design criteria. Provided information below is based on the Hydrotech Discfilter by Veolia.

System Criteria	Value
Number of Filter Units (duty/standby)	2 (1/1)
Rated Filter Capacity, each	6 MGD
Filter Pore Size,	10 µm
Filter Cloth Material	Polyester
Number of Filter Discs per unit	25
Total Allowable Installed Filter Discs per (Future) unit	26
Filter Disc Diameter	7.22 ft
Effective Filter Area (Submerged) per unit,	1,078 sf per unit
Total Filter Area	1,655 sf per unit
Peak Hydraulic Loading Rate	≤ 3.87 gpm/sf
Filter Drive Unit:	
Drive Motor (1 per unit)	1.5 HP, 460V, 3 phase
Drive Assembly	Drive Chain and Sprocket
Filter Rotational Speed	2.8 RPM
Backwash Cleaning System:	
Number of Backwash Nozzles (per Disc)	14
Backwash Pump (1 per unit)	25 HP, 460V, 3 phase
Backwash Pressure	95 psi
Design Backwash Flowrate	209 gpm
Backwash Water Pump	25 HP

Chemical Feed System – Metering Pumps Skid	Included
Mobile Automated Cleaning System	Included
Control System	Allen Bradley
Unit Control Panel Enclosure Type	NEMA 4X
Instrumentation – Level Sensors	One (1) lot
Chemical Pre-Treatment:	
Rapid Mixing Tank:	
Min. HRT	0.5 minutes
Mixer Drive Motor	15 HP
Coagulation Mixing Tank:	
Min. HRT	4 minutes
Mixer Drive Motor	5 HP
Flocculation Mixing Tank:	
Min. HRT	4 minutes
Mixer Drive Motor	5 HP

- C. The automatic backwash filter system shall be suitable for filtering domestic treated wastewater after secondary treatment and clarification. Filter shall be designed to operate on a continuous basis and shall be designed to operate while receiving varying flows.
- D. The automatic backwash filter system shall be suitable for filtering domestic treated wastewater from 14°C to 25°C.
- E. Filtration system shall utilize an “inside-out” flow pattern in which influent flows by gravity into the filter discs from the center drum. Solids are separated from the water by partially submerged filter media. Filtration systems with fully submerged media utilizing an “outside-in” flow pattern shall not be acceptable due to accumulation of solids in the basin, resulting in a dirty and unsanitary work environment for the plant operation staff.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Base Bid Manufactures:
 - 1. Veolia, Hydrotech Discfilter
 - 2. Or Engineer Pre-Approved Equal.
- B. The Tertiary Filtration treatment has been designed around Veolia Hydrotech Discfilter. Other named or approved equals may differ with respect to the structure, electrical power, or controls. Contractors shall include the capital cost and re-engineering cost differences associated with any such changes to the current plans as advertised and included such cost variation in the bid price.
- C. The design and layout shown on the drawings are based on the Manufacturer listed above. If equipment other than that of the Manufacturer shown is submitted to the Engineer for consideration as an equal, it shall be the responsibility of the CONTRACTOR wishing to make the substitution to submit with the request a revised drawings of the mechanical equipment and basin layouts acceptable to the ENGINEER.

- D. To be selected as an approved equal Manufacturer, it shall be responsibility of the Contractor to perform and submit a jar testing to confirm the viability of the Rare Earth (NEO WaterFX) coagulant and determine its effective dosage to achieve TSS and Phosphorus effluent concentration limits as listed in paragraph 1.7 A. of this specification.
- E. To be selected as an approved equal a submittal showing compliance with these specifications shall be submitted ten (10) days before bid opening. Selected equipment manufacturers will be added by addendum.
- F. Changes in architectural, structural, electrical, mechanical and plumbing requirements for the substitution shall be the responsibility of the CONTRACTOR wishing to make the substitution. This shall include the cost of redesign by ENGINEER or ENGINEER'S SUBCONSULTANTS. Any additional cost incurred by affected subcontractors shall be the responsibility of the CONTRACTOR and not the OWNER. Any such changes to the plans shall be stamped by a professional engineer registered the State of Ohio.

2.2 MATERIALS AND EQUIPMENT

- A. Materials of Construction: Only corrosion resistant materials shall be used in components traveling underwater.
 - 1. All fabricated metal shall be AISI 304 stainless steel unless otherwise stated in this specification.
 - 2. Filter panels shall be polyester filter cloth mounted on plastic frames with integrated rubber seals.
 - 3. Filter disc segments shall be injection molded ABS plastic.
 - 4. Flange connections shall be provided with AISI 304 stainless steel stub ends and loose stainless steel flange collar rings.
- B. Fabrication Standards:
 - 1. Fabrication shall be done in compliance with all applicable ASTM or equivalent standards.
 - 2. All welding in the factory shall use shielded arc, inert gas, MIG or TIG method. Filler wire shall be added to all welds to provide for a cross section equal to or greater than the parent metal. Butt welds shall fully penetrate to the interior surface and gas shielding to interior and exterior of the joint shall be provided. All components to be free of carbon contamination upon delivery to the job site. Where necessary, all components to be pickled and passivated to prevent corrosion.
 - 3. All welding is performed in accordance with American Welding Society (AWS): AWS D1.1 Structural Welding Code; AWS D1.6, ASME 9 and AWS D1.3, or equivalent.
 - 4. All fasteners shall meet ASTM F593.
 - 5. Filter panels shall be polyester filter cloth mounted on polypropylene grids with integrated rubber seals.

2.3 CENTER DRUM

- A. The center drum shall be a watertight, one piece, structural welded, AISI 304 stainless steel fabrication, open at one end to allow the influent to enter and have openings to the filter discs

for water distribution to the filter media. The center drum shall have lubricated bearings, which must be externally accessible via grease tubing and fittings for routine lubrication.

- B. The center drum must have allowance for future field installation of one (1) additional discs to each unit. Blinding seals/gaskets must be installed and secured with stainless steel band straps in order to cover the drum openings for the future additional disc, thus preventing influent water from passing through the unit without being filtered. These blinding seals/gaskets must remain in place until future installation of the expansion disc occurs.

2.4 DRUM ASSEMBLY

- A. The filter shall be composed of modular and removable discs. Each disc shall consist of disc segments that can be easily mounted or dismounted as required. The segments of one disc shall connect together with snap-fit joints, and the completed disc assembly shall be secured to the center drum with stainless steel band straps and hardware. Designs utilizing disc cassettes that do not allow media on one side of the disc to be replaced separately from the other side shall not be acceptable due to excessive amount of media that is to be replaced when media panel(s) are torn or broken.
- B. Filter panels (filter media) shall be mounted on the sides of the disc segments. The filter panels shall consist of plastic frames with PET monofilament filter fabric attached to the frames. Systems with pleated media, corrugated media, pile cloth media, or stainless steel media shall not be acceptable. Stainless steel media shall also not be accepted due to its susceptibility to corrosion and short life span caused by mechanical fatigue failure. Each panel shall be equipped with a rubber gasket that is fitted to and provided integral to the media frame to provide a watertight seal between the filter panels and disc segments. Designs that utilize stick-on adhesive compressible gaskets as seals between the media panels or between disc cassettes shall not be accepted due to lack of durability and potential for compromised effluent quality. The panels shall be held in place by an ABS plastic retaining cap. The cap shall be secured to the disc with a single bolt.
- C. Filter discs must be constructed of modular segments and each disc segment must include a substantially open area along the length of the radial support to allow the liquid to flow from one section to the other as the discs are rotated.
- D. The replacement of filter panels must be possible from outside the filter basin by unfastening the single bolt, removing the retaining cap and sliding the panels from the disc frame.

2.5 SUPPORT FRAME WITH COVER

- A. The support frame shall be structural welded 304 stainless steel. The support frame shall include 304 stainless steel supports for back-wash pump, drive gear box, and center shaft bearing house. Carbon steel construction shall not be acceptable in order to minimize maintenance efforts associated with corrosion and painting.
- B. The filter shall be furnished with a GRP (Glass fiber Reinforced Plastic) cover as a means to prevent algal growth and reduce the presence of filter flies. The cover shall be automated to allow it to be opened and closed without the need for manual lifting. The GRP cover must be designed to open from either side of the filter unit in order to allow personnel to access the disc segments and spray nozzles. Two magnetic motor actuators shall open and lift the cover. The actuators must meet IP66 classification for outdoor use and IP69K classification for wash-down duty. The

actuators must include mechanical overload protection via integrated slip clutch and shall include a hand crank to allow for manual operation. Manual operation must only be performed while the power supply is disconnected.

- C. Anchor bolts shall be provided by the contractor.

2.6 BACKWASH CLEANING SYSTEM

- A. The Discfilter shall be equipped with a single oscillating back-washing system with non-motorized moving spray headers for efficient cleaning of the filter cloth and for reduction of the consumption of backwash water. All panels shall receive 95 psi pressure backwash spray. Systems with separate solids removal and backwash discharge systems shall not be acceptable.
- B. The backwash system shall be comprised of stainless-steel backwash spray headers installed between the discs. Each spray header shall be connected to a multi-nozzle holder made of polypropylene plastic with glass reinforcement. The spray headers and multi-nozzle holder assembly shall oscillate in an upward and downward motion during drum rotation. The oscillation shall be operated by a cam system that is connected to the drum drive. Systems with stationary spray headers or with separate drive motors to oscillate the spray headers shall not be acceptable. Each multi-nozzle holder shall have flat pattern spray nozzles for each disc side. Each spray nozzle shall consist of a nozzle body, nozzle tip, and seal.
 - 1. The replacement of spray nozzles must be possible from outside the filter basin. A swivel joint shall allow the spray header manifold to rotate out for nozzle access without disassembly of the manifold or headers. A single magnetic motor actuator shall be used to automate the operation to access the nozzles. The actuator shall be the same type and model used for the GRP cover.
- C. Each filter shall have one externally mounted low-pressure Grundfos centrifugal pump for the backwash system.
 - 1. The backwash pump shall be provided integral to the Discfilter unit and shall be installed at the factory.
 - 2. The backwash pump shall be of the vertical multi-stage design with the motor mounted directly to the top of the pump.
 - 3. The motor shall be supplied by Grundfos integral with the pump. The motor shall be standard efficiency rated for 460V, 3 phase, 60 HZ operation.
 - 4. Filtered water shall be discharged from the pump to the backwash header piping constructed of stainless steel.
 - 5. A stainless steel housing with internal wire weave filtration cartridge shall be installed in the piping downstream of the backwash pump in order to protect the spray nozzles from being plugged with small particles.
 - 6. A stainless steel ball valve shall be installed in the piping downstream of the strainer housing for shut-off. A stainless steel braided hose assembly with ball valve shall be connected to the backwash piping upstream and downstream of the shut-off valve. The purpose of the shut-off valve and the braided hose assembly is to throttle the flow and pressure when performing nozzle inspection.
 - 7. A pressure gauge shall be installed in the backwash header piping downstream of the pump, strainer, ball valve and braided hose assembly in order to monitor the nozzle pressure.

- D. Each filter shall be equipped with a submersible pressure transducer for effluent water level measurement and shall be the Endress + Hauser FMX21 Submersible Pressure/Level Transducer.
- E. Each filter shall be equipped with a submersible pressure transducer for influent water level measurement. The submersible pressure transducer shall be the same type and model as the effluent pressure transducer. The backwash cycle shall be activated either by pressure differential measured between the influent transducer and effluent transducer or by manual operation.
- F. Each filter unit shall be supplied with a Back Wash (BW) pump dry run protection pressure switch. The BW pump dry run protection sensor shall be a Nautilus XMLA fixed differential single threshold pressure switch. The sensor shall be mounted in the piping downstream of the backwash pump. When the sensor is activated by low pressure it shall activate a relay inside the control cabinet to prevent running the pump.
- G. The transducers, level sensor, and pressure switch shall be installed on the unit at the factory and shall be wired to a common junction box located on the filter unit. The installing contractor shall provide all wiring, conduit, and terminations between the junction box and the control panel for the Discfilter.
- H. The Discfilter shall be equipped with a backwash-collecting trough for removing solids.
 - 1. The trough shall be constructed of GRP.
 - 2. The trough length shall be sufficient to capture reject water from all filter discs.
 - 3. The trough shall be elevated to prevent contact with the influent stream.
 - 4. The reject water shall leave the trough by gravity via the backwash outlet connection.
 - 5. Piping from the trough to the outlet connection shall be stainless steel connected with stainless steel shielded, flexible elastomeric PVC couplings.
 - 6. The backwash outlet connection shall be a 6-inch ANSI loose flange. Systems with separate solids removal and backwash discharge systems shall not be acceptable.

2.7 CHEMICAL SPRAY HEADER

- A. Each Discfilter shall be equipped with a header pipe for the purpose of allowing supplemental chemical cleaning of the discs. The header pipe shall have nozzles that direct a spray pattern to allow for application of chemical onto all filter panels. Each nozzle shall be polypropylene and shall be attached to the header pipe with a nozzle holder. The header pipe shall be attached to the inside of the filter. A camlock fitting shall allow for connection to the end of the header pipe.

2.8 DRIVE MECHANISM

- A. A drive assembly shall be incorporated to rotate the center drum assembly during the backwash cycles.
- B. The drive assembly shall consist of a gear motor, chain, and sprockets. The chain link and barrel material shall be FRP. Any design using a belt drive assembly shall not be acceptable for use due to risk of stretching and failure when driving loads of this magnitude. The gear motor shall be SEW Eurodrive shaft mounted helical worm gear with integral standard AC induction motor. The motor shall be rated for 1.5 HP, 460V, 3 phase, 60 HZ operation.

- C. The drive assembly shall also provide oscillation of the backwash spray headers without the need for a separate drive motor in order to provide for efficient cleaning of the filter media with minimal water usage and minimal energy usage. Systems with stationary spray headers and/or separate drive motors shall not be accepted for use.

2.9 FLOW BYPASS

- A. The bypass means shall be constructed by others and shall be at the inlet side of the filter unit. Filter unit shall be capable of bypassing influent flow and shall be constructed to prevent overflow from entering the filtered water collection basin which acts as the source for backwash water.

2.10 DISFILTER SPARE PARTS

- A. The following spare parts will be supplied:
 1. Ten (10) Backwash Spray Nozzles
 2. Five (5) Filter Panels

2.11 AUTOMATED CLEANING SYSTEMS (ACS)

- A. The equipment manufacturer shall furnish an automatic cleaning system that applies a chemical spray to the media in order to remove either organic or inorganic foulants. The system must be integrated into the design of the filter system and must include spray nozzles, chemical storage tank(s), chemical dosing pump(s), and other appurtenances as required for automated operation. The system must allow for operations staff to simply engage the system and initiate operation at the unit. The system must be initiated to begin the cleaning cycle from the HMI and/or selector switches located on the front of the filter unit control panel. Once initiated, the system must provide for media cleaning while being fully automated from the control panel. System must provide spray application of chemical to the filter media and may not depend on use of "soak" or "bath" techniques for media cleaning. Equipment manufacturer must demonstrate that the system has been designed and implemented in previous Discfilter installations for chemical cleaning. The automatic cleaning system and controls shall be provided by the Discfilter equipment supplier.

2.12 EFFLUENT WEIR PIPE ASSEMBLY

- A. Weir assemblies fabricated in 304 SSSL are to be provided by the filter manufacturer and installed by the contractor as indicated in the contract drawings. The assemblies must provide adequate weir length to allow for operation of the filtration equipment throughout the specified flow ranges within the hydraulic profile detailed in the contract drawings.

2.13 CONTROL PANEL AND OPERATION

- A. The Discfilter operation shall be managed by an automated control system. The automatic control shall be designed around a Programmable Logic Controller (Allen Bradley Micro850).
- B. The control system is an integral part of the Discfilter system and shall be provided in a UL labeled, NEMA 4X 304 Stainless Steel enclosure. Each Discfilter unit shall include a control system which shall consist of a programmable controller, fused main disconnect, control transformer, branch circuit breakers, IEC motor starter/protector, hand-off-automatic switches, and liquid level sensor

relay for initiating backwash. The power feed to the control panel shall be 480VAC / 60Hz, 3 phase. Control voltage shall be 120VAC / 60 Hz, 1 phase.

- C. The control panel enclosure shall meet the following criteria, 304 Stainless Steel, seams continuously welded and ground smooth, seamless foam-in-place gasket for watertight dust-tight seal, door opens 180°, quarter turn latches opened or closed using a screwdriver, and NEMA Type 4X, UL Listed. The enclosure shall be Saginaw SCE-60EL3612SSLP or approved equal.
- D. The main disconnect shall be enclosed in the control panel, with a handle mechanism extending through the door. The main disconnect shall be a fused disconnect rated for 30 Amps 3-Pole. The main disconnect shall be composed of three primary components; 30A fused disconnect, extension shaft, NEMA 4X operating handle. Components shall be Square D GS1DU3 fused disconnect, GS2AH420 disconnect handle and GS2AEH12 disconnect shaft or approved equal.
- E. Field wiring terminal blocks for the Discfilter Control Panel shall be din rail mountable, individually numbered, rated for 600 Volts 30 Amps. The field wiring terminal blocks shall be Phoenix UTTB4 3044814 or approved equal.
- F. Motor wiring terminal blocks for the Discfilter Control Panel shall be din rail mountable, individually numbered, rated for 600 Volts 65 Amps. The field wiring terminal blocks shall be Phoenix UT10 3044160 or approved equal.
- G. A motor starter located in the Discfilter Control Panel shall manage the Start/Stop of the Backwash Pump motor. The motor starter shall be sized appropriately to match the requirements of the Backwash Pump motor. The motor starter shall be an IEC starter rated between 0.1 and 50 Amps @ 460VAC 3 phase, with rotary handle operator, visible trip indication, protection by overload, short circuit, undervoltage and shunt. The motor starter shall be equipped with auxiliary contacts for monitoring and control. The IEC motor starter shall be Square D TeSys or approved equal.
- H. A VFD located in the Discfilter Control Panel shall manage the start/stop of the Filter Drum motor. The VFD shall be sized appropriately to match the requirements of the Filter Drum motor. The VFD shall be equipped with an integral keypad display for VFD interface and configuration, use sensorless flux vector technology, use with 3-phase asynchronous motors, monitoring and control inputs and outputs, motor and drive protection. The VFD shall not require input/output filters or harmonic testing. The VFD shall be hardwired for control and monitoring and will not require any communication protocols such as Ethernet, DeviceNet, and Modbus. The VFD shall be Square D Altivar 320 or approved equal.
- I. The control panel shall have external selector switches (Hand-Off-Automatic). The selector switches shall be NEMA 4X, 30mm, non-illuminated, manual return and equipped with contact blocks. The selector switches shall be Square D 9001 SKS43BH2 or approved equal. The control panel selector switches shall allow the drum drive and backwash motor to be operated in Hand mode.
- J. The completed control panel shall be UL labeled per UL508A. The completed control panel shall be factory tested and configured.
- K. The Programmable Controller shall perform logic, timing, counting and real time clock operations. The Programmable Controller shall be programmed using software to allow configuration of a downloadable program featuring input instructions, output instructions, timer instructions, counter instructions, and counter instructions. The Programmable Controller shall be equipped with a embedded 10/100 Base -T EtherNet/IP Port as well as USB programming port. The

Programmable Controller shall be equipped with a minimum twenty-eight (28) Digital Inputs (120VAC) and twenty (20) Relay Outputs, additional I/O can be added via I/O expansion modules. The Controller shall be an Allen Bradley Micro850 2080-LC60-48AWB or approved equal.

- L. The control system shall be supplied with one Operator Interface. The Operator Interface shall be capable of communicating with the Programmable Controller. The Operator Interface shall be capable of displaying text and graphics, allow operator setpoint entry, and provide system status display. The Operator Interface shall be a color touchscreen display, minimum ten (10) inch diagonal, 10/100 Base-T Ethernet Port and mount to the panel front. The Operator Interface shall be Allen Bradley 2711R-T10T or approved equal.
- M. The control system shall allow for continuous back washing when the motor switches are placed in HAND mode.
- N. The Contractor is responsible for providing interconnecting wiring and/or conduit between the supplied control panel and Discfilter equipment. The Contractor shall provide any junction or pull boxes, or any other like device needed to supply the interconnecting wiring.
- O. All field connections/terminations to the supplied control panels, the Discfilter equipment, and between the Discfilter equipment and supplied control panels shall be the responsibility of the Contractor.
- P. Each filter unit shall be supplied with a "High-High Level" sensor. The "High-High Level" sensor shall be mounted in such a way as to ensure that the device indicates when the water reaches a height above the backwash level sensor and has entered a High-Level scenario. When the "High-High Level" sensor is activated, it will activate a relay inside the control cabinet and a pilot light on the front of the control panel shall illuminate. The pilot light shall be labeled "Discfilter High-High Level". The "High-High Level" relay shall have a spare set of normally open dry contacts available for monitoring. The liquid level relay shall be Square D RM35LM33MW with relay base or approved equal.

2.14 PROCESS MIXING TANKS

- A. In concrete by others, consisting of a rapid mixer, coagulation mixer, and flocculation mixer. The Rapid, Coagulation, and Flocculation tanks shall be constructed by the Contractor but designed in accordance with Equipment Manufacturer's recommendations.

2.15 VERTICAL SHAFT MIXERS

- A. Each mixer assembly shall consist of a speed reducer, premium efficient electric motor, baseplate, agitator shaft, and mixing impellers. Mechanical details of each component shall be as follows:
 1. The mixer gear drive must be built in accordance with the current AGMA Standards. The AGMA calculated drive HP rating shall be stamped on the drive nameplate. Drive housings shall be of high-quality close-grained cast iron or fabricated steel, stress relieved and reinforced, and shall be provided with lifting lugs. Each unit shall be provided with an integral or separate baseplate and shall have a minimum 12" pedestal base for ease of assembly of the agitator shaft and to facilitate drainage of the oil from the gear drive.
 2. Gearing must be vertical parallel shaft all helical gears or helical spiral bevel to ensure the highest efficiency coupled with the convenience of mounting and maintenance (worm gearing is not acceptable). Helical gears shall be a minimum AGMA Quality 9 per AGMA

standard 390.03. Spiral/bevel sets shall be a minimum AGMA Quality 8, matched and lapped. The gears shall be lubricated from a common oil bath or grease lubricated. The full load operating noise levels of the mixer drives shall not exceed 85 dBA at 3 feet from any part of the drive assembly.

3. The mixer gear drive shall be designed with an output shaft system suitable for the loadings imposed by the specific duty. The drive's minimum AGMA service factor shall be 1.5 and based upon motor nameplate horsepower. Service factors based on uniform load and motor bhp will not be accepted. Agitator gear drive coupled to the impeller shaft must be designed, manufactured, and tested by the mixer supplier.
4. All drive bearings shall be of the antifriction type, ball or roller bearings. All bearings within the drive, including output shaft bearings, shall have minimum AFBMA B-10 lives of 50,000 hours when operating at full motor nameplate horsepower at design speed.
5. Each drive must have an effective lubrication of rotating elements without leakage down the output shaft. Output shaft bearings may be grease lubricated.
6. The electric motor shall have a 1.15 service factor and TEFC/TENV enclosure with class F insulation and class B temperature rise above 40° C ambient. The motors shall be squirrel cage induction motors for operation on 3 phase, 60 hertz, 230/460 Volt current with synchronous speed of 1800 RPM or less. Motors shall be premium efficiency type and rated for severe duty. Efficiency shall be determined in accordance with IEEE 112, Test Method B. Flocculation mixer motors are to be used with AC inverters that shall meet NEMA MG1, part 31 for variable torque, 10:1 turndown operation. The motor shall be connected to the input shaft with a rigid or flexible coupling and shall be pilot mounted. Integral mounted motors shall be accepted. All motors shall be designed, constructed, and tested in accordance with applicable IEEE, NEA, and ANSI, standards. Provide motor heaters and gearbox oil heaters for the mixers. Heaters would require 120V/60Hz/1 phase power.
7. The lower mixer shaft shall be connected to the upper, or drive output shaft, by means of a rigid flanged or integral coupling.
8. The agitator shaft shall be of 316 stainless steel construction or other approved material as recommended by the mixer manufacturer. The shaft shall be designed such that the combined (Mohr's circle) maximum shear stress shall not exceed 9,000 psi under maximum operating loads for stainless steel. It shall be of overhung design for use in complete coverage (liquid levels at least one impeller diameter above the impeller height). The use of underwater steady bearings is not permitted.
9. Impellers shall be constructed of 316 stainless steel or other approved materials as recommended by the mixer manufacturer. Impellers shall be bolted construction and shall be connected to the agitator shaft with an open key for maximum security if round shaft or as required. The maximum stress in any impeller component shall not exceed 11,000 psi under maximum operating loads.
10. Upon installation, each unit shall be run to demonstrate its ability to operate without overloading, jamming, or excessive vibration during normal operation.

B. Materials

1. Motor and gearbox shall be shipped with manufacturer's standard factory paint, suitable for use as a finish coat. All touch-up and additional coats are to be applied in the field by the Contractor. Wetted parts, of 316 stainless steel, shall not be painted.

C. Controls

1. The Rapid/Coagulation/Flocculation Mixer operation shall be managed by an automated control system. The automatic control shall be designed around an Allen Bradley Micro850 Programmable Logic Controller.
2. The control system is an integral part of the Rapid/Coagulation/Flocculation Mixer system and shall be provided in a UL labeled, NEMA 4X 304 Stainless Steel enclosure. The control system shall consist of a programmable controller, fused main disconnect, control transformer, branch circuit breakers, IEC motor starter/protector, and hand-off-automatic switches. The power feed to the control panel shall be 480VAC, 60Hz, 3 phase. Control voltage shall be 120VAC, 60 Hz, 1 phase.
3. The control panel enclosure shall meet the following criteria: 304 Stainless Steel, seams continuously welded and ground smooth, seamless foam-in-place gasket for watertight dust-tight seal, door opens 180°, quarter turn latches opened or closed using a screwdriver, and NEMA Type 4X. The enclosure shall be Saginaw SCE-60EL3612SSLP or approved equal.
4. The main disconnect shall be enclosed in the control panel, with a handle mechanism extending through the door. The main disconnect shall be a fused 3-Pole disconnect. The main disconnect shall be composed of three primary components; fused disconnect, extension shaft, NEMA 4X operating handle. Components shall be Square D GS1DU3 fused disconnect, GS2AH420 disconnect handle and GS2AEH12 disconnect shaft or approved equal.
5. Field wiring terminal blocks for the Disfilter Control Panel shall be din rail mountable, individually numbered, rated for 600 Volts 30 Amps. The field wiring terminal blocks shall be Phoenix UTTB4 3044814 or approved equal.
6. Motor wiring terminal blocks for the Rapid/Coagulation/Flocculation Mixer Control Panel shall be din rail mountable, individually numbered, rated for 600 Volts 65 Amps. The field wiring terminal blocks shall be Phoenix UT10 3044160 or approved equal.
7. The VFDs located in the Control Panel shall manage the Start/Stop of the mixers. The VFDs shall be sized appropriately to match the requirements of each mixer. The VFDs shall be equipped with an integral keypad display for VFD interface and configuration, use sensorless flux vector technology, use with 3-phase asynchronous motors, monitoring and control inputs and outputs, motor and drive protection. The VFDs shall not require input/output filters or harmonic testing. The VFDs shall be hardwired for control and monitoring and shall not require any communication protocols such as Ethernet, DeviceNet, and Modbus. The VFDs shall be Square D Altivar 320 or approved equal.
8. The control panel shall have external selector switches (Hand-Off-Automatic). The selector switches will be NEMA 4X, 30 mm, non-illuminated, manual return and equipped with contact blocks. The selector switches shall be Square D 9001 SKS43BH2 or approved equal. The control panel selector switches shall allow the drum drive and backwash motor to be operated in Hand mode.
9. The completed control panel shall be UL labeled per UL508A. The completed control panel will be factory tested and configured.
10. The Programmable Controller shall perform logic, timing, counting and real time clock operations. The Programmable Controller shall be programmed using software to allow configuration of a downloadable program featuring input instructions, output instructions, timer instructions, counter instructions and counter instructions. The Programmable Controller shall be equipped with an embedded 10/100 Base -T EtherNet/IP Port as well as USB programming port. The Programmable Controller shall be equipped with a minimum fourteen 28 Digital Inputs (120VAC) and ten (20) Relay Outputs, additional I/O can be added

via I/O expansion modules. The Controller shall be an Allen Bradley Micro 850 2080-L60E-48AWB or approved equal.

11. The control system shall be supplied with one Operator Interface. The Operator Interface shall be capable of communicating with the Programmable Controller. The Operator Interface shall be capable of displaying text and graphics, allow operator setpoint entry, and provide system status display. The Operator Interface shall be a color touchscreen display, minimum four (4) inch diagonal, 10/100 Base-T Ethernet Port and mount to the panel front. The Operator Interface shall be Allen Bradley 2711R-TxT or approved equal.
12. The control system shall allow for continuous back washing when the motor switches are placed in HAND mode.
13. The Contractor is responsible for providing interconnecting wiring and/or conduit between the supplied control panel and Discfilter equipment. The Contractor shall provide any junction or pull boxes, or any other like device needed to supply the interconnecting wiring.
14. All field connections/terminations to the supplied control panels, the Discfilter equipment, and between the Discfilter equipment and supplied control panels shall be the responsibility of the Contractor.

D. Manufacturer

1. The mixers shall be manufactured by WWT, Philadelphia Mixer, Lightnin or equal.

2.16 COAGULANT METERING SYSTEM

A. General: The City of Sunbury WWTP uses a Rare Earth (NEO WaterFX) coagulant. A jar test was performed to determine viability of the Rare Earth coagulant and determine its effective concentration in TSS and Phosphorus reduction. According to the jar test, the concentration range of the Rare Earth (NEO WaterFX) coagulant is 15-30 mg/L.

B. Coagulant Dosing System

1. The chemical metering pump skid systems of this section shall be manufactured by Watson Marlow, or Discfilter Supplier approved equal.
2. The coagulant pumps shall be capable of at least 0.003 - 5 gph up to 100 psi of flow rate production with an average flow of 1.3 gph at Average Design Day flow of 2 mgd.
3. The chemical metering skid shall be self-contained and designed to feed required amounts of Coagulant. The chemical metering skid shall include one (1) skid with duplex peristaltic metering pumps. The metering pumps shall be capable of both manual and automatic control. Automatic control shall be accomplished by following a 4-20 mA control signal through a controller provided by the skid or pump manufacturer. The metering pump skid will be completely assembled, wired, and pre-tested prior to delivery to the job site.
4. The chemical metering skid shall be constructed of fusion welded, UV-protected polypropylene or HDPE sheets with adequate supports for all equipment and piping. Skid shall be suitable for floor, include a hinged clear polycarbonate cover.
5. All piping shall be Schedule 80 PVC and assembled by the skid manufacturer. All piping shall be socket-welded using standard procedures. Where threaded connections need to be made the manufacturer will utilize Teflon tape and a suitable thread sealant.

6. The pump drive case shall be constructed of 20% Glass Filled PPE/PS with stainless steel 440C driveshaft. The pump user interface shall include a NEMA 4X high-visibility 3.5" TFT color display. The pump element shall be a constructed of a material compatible with the fluid handled.
7. The pump head shall be Watson Marlow self-contained ReNu technology which includes integral leak detection and require no tools for replacement.

C. Controls

1. Each skid shall be provided with a single skid mounted NEMA 4X control panel for both pumps. The terminal box shall include the necessary terminal blocks for all pump required functions.
2. Control panel power shall be 115-volt, 60 Hertz, single phase.
3. Pump shall be capable of having outputs for Auto Status, Run Status, and Fail Status. Pumps shall be capable of operating with a 4-20 mA signal input and have start/stop command capabilities. All controls shall be integral to the pump.

2.17 LIQUID POLYMER PREPARATION SKID SYSTEM

A. General

1. The liquid polymer preparation system shall be capable of metering precise amounts of liquid polymer and water and subsequently processing the mixture to provide a fully activated polymer solution.
2. The liquid polymer preparation module shall utilize an effective, two-stage activation system to produce a precise, uniform and thoroughly activated solution in a compact package.
3. All components of the system shall be mounted on an 11-gauge, 304 stainless steel base plate with rolled edges for containment and rigidity. The control panel, rotameter, and pump shall be factory mounted on the base plate along with the activation chamber and other system components. All components shall be mounted, wired, and piped by the manufacturer. The unit shall have an open frame for ease of maintenance and to provide visual observation of its operation.

B. Components

1. Progressive Cavity Type Neat Polymer Metering Pump: The preparation module shall be provided with a progressive cavity metering pumps (total of 2, one operational and one standby) to meter polymer for the activation. The pump materials shall be inert to all polymers and carrier materials and shall be capable of handling all liquid emulsion polymers. The pump shall be provided with the ability to accept a 4-20 mA signal for remote control of the pump speed.
2. Water Controls: The liquid polymer preparation system shall include a rotameter, flow-adjusting valve, and solenoid valve for control of dilution water.
3. This specification is based on a multi-stage, multi-zone, Hydro-Mechanical polymer activation & blending technology. Alternate technologies will only be considered if proven to provide an equal level of performance, versatility, reliability, and quality, otherwise the following technology will be provided without exception.

4. A multi-stage Hydro-Mechanical polymer blending technology shall be provided with both a non-mechanical and mechanical mixing stage:
 - a. Non-Mechanical Stage device shall be capable of activating and blending polymer based on plant water pressure alone at 30 psig or greater. Polymer shall be injected directly into a water jet by means of an injection quill positioned such that the non-mechanical mixing energy is in no way diminished prior to polymer and water contact. The non-mechanical zone shall be designed such that the velocity of the mixing energy producing water jet is maintained or increases as flow decreases.
 - b. Hydro-Mechanical Mixing Stage device shall be capable of producing its mixing energy independent of plant water pressure through a variable intensity, controllable stainless steel hydro-mechanical mixer. The mixing impeller shall be fully controllable and capable of inducing ultra-high, non-damaging mixing energy at all flow rates. This shall be accomplished by controlling mixing intensity and preventing over exposure to, or damaging recirculation through the impeller. The polymer mixing impeller shall be designed to produce both axial and radial flow to optimize mixing effectiveness and to effectively inducing high, non-damaging mixing energy over the systems full flow range.
 - c. Mixers that rely solely on plant water pressure and or flow for mixing energy will not be acceptable. Mixers where performance is affected by flow rate and therefore retention time resulting in under or over exposure to mixing energy, or which rely on constant speed impellers or on close tolerances for blending shall not be acceptable,
 - d. In order to prevent polymer build-up, the mixing chamber shall maintain high velocity in the entire chamber - at no time shall there be low velocity within any portion of the mixing chamber.
 - e. The mixing impeller shall be controlled by an SCR motor controller and driven by a wash-down duty motor. The motor shall be mounted horizontally or above the mixing chamber. Motors mounted under the mixing chamber where seal failure or leaks can damage the motor shall not be acceptable.
 - f. The mixer drive shaft shall be sealed by a mechanical seal which shall have an integrally mounted and factory plumbed seal flush. A drain hole behind the seal shall be provided in the mixing chamber to drain the polymer solution in case of a seal failure. The seal shall be easily accessible for replacement. Systems without a seal flushing system shall not be considered. Systems with holes in the mixing impeller to "pull" polymer away from the seal shall not be acceptable or used, as this feature fails to prevent polymer from coating the shaft seal face. All bearings shall be external from the mixing chamber. Internal bearings shall not be acceptable.
 - g. Both mechanical and non-mechanical mixing zones shall be clear polycarbonate to view the mixing action and blending effectiveness. Acrylic chambers prone to becoming brittle over time and cracking, or opaque pipe shall not be acceptable to meet this requirement. The clear cover shall have a stainless steel reinforced gusseted flange with a stainless-steel discharge connection in order to handle maximum operating pressures.
5. Provide a neat polymer check valve specifically designed to isolate neat polymer from dilution water.
 - a. The valve shall be designed with an open, unobstructed path to the valve seat. To minimize check valve plugging due to normally occurring polymer agglomerations, the minimum open area up to and including the valve seat shall be 3/16" without exception.
 - b. The valve body shall be constructed of Teflon with Viton seals.

- c. The valve poppet and spring shall be stainless steel. The spring shall be outside of the polymer flow path to prevent build-up and plugging.
 - d. The locking pin used to hold the valve in place shall be attached to the mixing chamber with a lanyard.
 - e. The valve shall be readily accessible for cleaning and shall not require tools for removal, cleaning, or replacement.
 - f. Conventional check valves, valves that rely on ball seals, and or check valves that are installed inside the mixing chamber, or which require mixing chamber disassembly for servicing shall not be accepted.
6. Dilution water system
- a. The dilution water flow rate shall be monitored by a Rotameter flow. Unions or flanges shall be provided on the flow meter to allow easy removal for cleaning.
 - b. The unit shall have an electric solenoid valve for "ON/OFF" control of total dilution water flow.
 - c. A differential pressure type low water differential pressure alarm shall be provided. The switch shall be adjustable between 9 and 60 psig. Static working pressure, 500 psi. The pressure switch shall be as manufactured by Ashcroft.
 - d. Provide a 2-1/2" stainless steel liquid filled pressure gauge to monitor dilution water inlet pressure.
7. Progressive Cavity Type Made-Down Polymer Metering Pumps: Progressive cavity metering duplex pumps skid system shall be supplied, for metering of made-down polymer from the liquid polymer processing system aging tank to the coagulation and flocculation process.
8. The unit shall have two (2) neat polymer metering pump(s) integrally mounted on the systems skid. The pump shall be a positive displacement, progressive cavity type constructed of stainless steel and Viton. The shaft seal shall be an adjustable packing type. Mechanical seals shall not be used. A 90 VDC wash-down duty motor shall drive the pump. A gear reducer shall be provided to produce a maximum pump shaft speed of not more than 545 RPM. The motor shall be controlled by an SCR motor controller located in the system control panel.
9. Neat Polymer Metering Pumps:
- a. The preparation module shall be provided with a progressive cavity metering pump to meter polymer for activation.
 - b. Type: Progressive Cavity
 - c. Qty. Two (2) pumps Duty/Standby
 - d. Polymer Flow Range Pump: 0.15 gph to 3 gph each. The average flow of emulsion polymer is 0.3-0.5 gph at Average Day Design Flow of 2 MGD.
 - e. Motor: 1/2 HP, 208-230/460 VAC, 3 Ph, 60 Hz motor with Gear Reducer
10. Provide a calibration column with two full port PVC ball valves having Viton O-rings. The column shall be calibrated for a one-minute draw-down at maximum pump rate and read in GPH and milliliters. The calibration column shall be rigidly mounted to the systems frame with a minimum of two heavy duty brackets. Mounting the calibration to the neat polymer inlet piping shall not be acceptable. Provide a breather plug in the top of the calibration column designed to allow adequate displacement of air during calibration while preventing water or other foreign material from entering the calibration column.
11. Provide a thermal type of loss of polymer flow sensor. The flow sensor shall include a stainless-steel plumbing assembly with a stainless-steel full port ball valve for draining during cleaning.

12. The aging tank shall be at least 250 Gallons, 11-gauge, 304 stainless steel, furnished with a (full) cover on which the level transmitter shall be mounted. Labyrinth baffles shall be provided to promote a plug flow pattern within the tank to optimize polymer detention. Plastic or fiberglass tanks will not be acceptable. Open-top tanks will also not be acceptable.
13. Ultrasonic level transmitters shall be mounted on the age tank cover to provide level-alarm indication and to provide a continuous display of the level in the tank controlled through the polymer supplier control panel. The control and alarm set-points shall also be settable through this display. The ultrasonic level transmitters shall have a range of 0.033 to 6 feet, a resolution of 0.03 inches, 4 to 20 mA output, and simple push-button calibration. Operating frequency shall be 148 kHz. Level transmitters shall not extend more than 5 inches from the top of the tank covers. Level sensing devices that come into physical contact with the polymer solution will not be acceptable.

C. Controls

1. A control panel integral to the systems frame shall be provided. The enclosure shall be rated NEMA 4X and constructed of FRP. The control panel shall consist of all controllers, digital displays, potentiometers, switches, lights, relays, and other control devices required for a complete operable system. The control panel and all components shall be industrial duty. All skid mounted electrical components interconnected to the control panel shall terminate at numbered and labeled terminal blocks. The terminal blocks shall be sized for 14 ga. wire. Wires shall be neatly run through wire raceway and numbered with shrink tubing type labels. Adhesive labels shall not be used. The control panel shall be positioned such that there are no obstructions in front of the control panel per related NFPA requirements. Controls to be supplied shall include vendor supplied PLC and HMI for a complete and operational standalone system which automatically adjusts polymer concentration based on user input and process supplied flow.
2. Control Panel Power: 120 VAC, 1Ph, 60/50 Hz. with a 10' power cord and receptacle.
3. EBX Control Series: Operator Interface
 - a. Operator Interface – Discrete Selector Switch:
 - b. System ON/OFF (Reset) / Remote
 - c. Neat polymer pump selector 1 or 2
 - d. Ten-Turn Potentiometer – Neat Polymer Pump Control 1
 - e. Ten-Turn Potentiometer – Neat Polymer Pump Control 2
 - f. One-Turn Potentiometer – Mixer Speed
 - g. Ten-Turn Potentiometer – Progressive Cavity Metering Pump Control
4. Status / Alarm Indicators:
 - a. Main Power "ON"
 - b. Display of Metering Pump Rate
 - c. LED Aging Tank Level
 - d. LED Neat Polymer Pump rate
 - e. Low Water Differential Pressure Alarm
 - f. Low Polymer Flow Alarm
5. Inputs (signals by others):
 - a. Remote Start/Stop (Based on Tank Level)
 - b. Pacing Signal Based on Process Flow (4-20mA)
6. Outputs:
 - a. System Running (discrete dry contact)

- b. Remote Mode (discrete dry contact)
- c. Common Alarm (discrete dry contact)
- d. Polymer Pump Rate (4-20mA)

D. Acceptable Manufacturers

- 1. The liquid polymer processing system shall be manufactured by VeloDyne, or Discfilter Supplier approved equal.

2.18 POLYMER METERING PUMPS

A. General:

- 1. The dilute polymer feed skid system described in this section shall contain progressing cavity pumps as manufactured by Moyno, Netzsch, or Discfilter Supplier approved equal.
- 2. The dilute polymer feed skid shall be self-contained and designed to feed required concentrations of polymer. Each polymer feed skid shall include (2) single stage progressing cavity pumps. The progressing cavity pumps shall be capable of both manual and automatic control. Automatic control shall be accomplished by following a 4-20 mA control signal through a controller to be provided by the skid manufacturer. The metering pump skid will be completely assembled, wired, and pre-tested prior to delivery to the job site.
- 3. The polymer feed skid shall be constructed of heavy-duty corrosion resistant material with adequate supports for all equipment and piping. Forklift truck cutouts to be provided. Each progressing cavity pump shall be mounted onto an individual baseplate as a pump unit. Each pump unit shall contain a single stage progressing cavity pump with independently mounted gear reducer and NEMA motor. Each pump unit shall be shimmed, aligned, and built independently of the structural skid.
- 4. Polymer feed pump system piping shall include: one (1) common calibration column, one (1) high pressure cut off switch per pump, one (1) pressure gauge per pump, one (1) dilution water line, one (1) discharge sample port w/ isolation valve, all required piping, valves, supports, and flushing ports. All piping shall include isolation valves and unions for all serviceable components. Pump skid dilution water line shall contain one (1) solenoid valve, one (1) rotameter, one (1) pressure gauge, two (2) ball valves, one (1) static mixer with diluted polymer discharge connection mounted on the vertical back panel.
- 5. All piping shall be Schedule 80 PVC and assembled by the skid manufacturer. All piping shall be socket-welded using standard procedures. Where threaded connections need to be made the manufacturer will utilize Teflon tape and a suitable thread sealant.
- 6. The pump housing shall be of cast iron or 316 stainless steel. The bearings shall be grease lubricated roller type. The pump shall have PTFE packing or mechanical seal. The pump shall have a chrome plated hardened alloy or 316 rotor with a 70 dM Nitrile or Viton stator.

B. Controls:

- 1. Each skid shall be provided with a single skid mounted NEMA 4X control panel for both pumps. The panel shall have a main disconnect, Local/Off/Auto selector switches, motor speed adjustment knob or controller keypad, and indicator lights for unit run, fail, and high-pressure alarm. The control panel shall include an analog signal splitter for lead lag pump operation.
- 2. Control panel power shall be 115 volt, 60 Hertz, single phase.

3. Control panel shall have dry contacts for pump outputs for the following signals:
 - a. Operator Interface
 - 1) Discrete Selector Switch: System ON/OFF (Reset) / Remote
 - 2) Pacing Select LOCAL/REMOTE
 - 3) Post Dilution ON/OFF/AUTO
 - 4) Ten-Turn Potentiometer – Neat Polymer Pump Control 1
 - 5) Ten-Turn Potentiometer – Neat Polymer Pump Control 2
 - b. Status / Alarm Indicators
 - 1) Main Power ON
 - 2) Display of Metering Pump Rate
 - 3) LED Neat Polymer Pump Rate
 - 4) Loss of Solution Flow Alarm
 - 5) High Pump Discharge Pressure
 - c. Inputs (signals by others):
 - 1) Remote Start / Stop (Based on Tank Level)
 - 2) Pacing Signal Based on Process Flow (4-20mA)
 - d. Outputs:
 - 1) System Running (discrete dry contact)
 - 2) Remote Mode (discrete dry contact)
 - 3) Common Alarm (discrete dry contact)
 - 4) Polymer Pump Rate (4-20mA)

PART 3 - EXECUTION

3.1 GENERAL

- A. All the plumbing/interconnecting piping, electrical connections, grating and handrails shall be provided by the Contractor as detailed on the drawings and specifications.
- B. Contractor shall install the Discfilter system per the Equipment Manufacturer's directions and the drawings. The Contractor shall provide all supports and anchoring required to install the Discfilter unit. The plumbing/interconnecting piping, electrical connections, grating and handrails shall be provided by the Contractor as detailed on the drawings and specifications including winterization such as piping insulation or heat tracing/heat tape. The Equipment Manufacturer shall provide adequate protection of the equipment for shipment to the project site. Installation instructions shall be provided that specifically outline installation of the Discfilter. Lifting instructions shall be provided to assist the Contractor.

3.2 DELIVERY

- A. The Equipment Manufacturer shall provide adequate crating and protection of the Discfilter automatic backwash filter for shipment to the project site. Installation instructions shall be provided that specifically outline installation of the Discfilter. Lifting instructions shall be provided to assist the Contractor.
- B. All equipment shall be shipped and delivered fully assembled, except where partial disassembly is required in order to conform to transportation regulations or for the protection of components.

3.3 INSTALLATION

- A. Equipment shall be installed in strict conformance with the manufacturer's installation instructions, as submitted with Shop Drawings, Operation and Maintenance Manuals and/or any pre-installation checklists. Installation shall utilize standard torque values and be installed secure in position and neat in appearance. Installation shall include any site preparation tasks as required by the Engineer or Manufacturer, such as unloading, touch-up painting, etc. and any other installation tasks and materials such as wiring, conduit, controls stands as determined by the Owner and/or specified by the Manufacturer.
- B. Anchor Bolts: Anchors, anchor bolts, nuts and washers shall be 304 stainless steel and furnished for each item of equipment by the Contractor.
 - 1. Anchor bolt template drawings shall be included in the submittal to permit verification of the location structural elements, new or existing in the concrete.
 - 2. Equipment manufacturer shall specify ample size and strength required to securely anchor each item of equipment. Anchor bolt template drawings shall be included in the submittal to permit verification of the location structural elements, new or existing in the concrete.
 - 3. Anchor bolts shall be set by the contractor. Equipment shall be placed on the foundations, leveled, shimmed, bolted down, and grouted with a non-shrinking grout.

3.4 TESTING

- A. After completion of installation, the Contractor shall provide for testing. Testing shall be performed in strict conformance with the manufacturer's start up instructions.
- B. Field certification shall include inspection of the following:
 - 1. Verify equipment is properly aligned and anchored per the installation instruction and drawings.
 - 2. Assure controls and instrumentation work in all modes.
 - 3. Check equipment for proper operation as well as completion of the Start-Up requirements in the installation guide.

3.5 FIELD SERVICES

- A. The equipment Manufacturer shall furnish the services of a factory-trained representative for a minimum of four (4) working days and two (2) separate trips. These two trips shall consist of one (1) trip for inspection and check-out (dry/wet/electrical) and one (1) trip for start-up and instruction of plant operating personnel. The Contractor shall provide to the Equipment Manufacturer a minimum prior notice of three (3) weeks in order to schedule these services.
- B. The manufacturer of the system shall provide a representative to check the installation, make final adjustments, supervise the initial startup of each mechanism, and prepare a written report thereof for the Owner.
- C. After completion of the installation, the equipment shall be tested by the Contractor in the presence of the Engineer under actual operating conditions. The test shall be conducted under the supervision of the manufacturer's technical representative. The Equipment Manufacturer Representative shall provide a written report attesting that the units have been properly installed and placed into satisfactory operation.

3.6 LUBRICATION

- A. The equipment shall be lubricated by the Contractor when erected and he shall furnish the necessary oil and grease for one (1) year of operation. The grades of oil and grease shall be in accordance with the recommendations of the manufacturer.

3.7 OPERATION AND MAINTENANCE MANUALS

- A. Prior to or with the delivery of equipment, the manufacturer shall provide copies of an operation and maintenance manual including storage, installation, start-up, operating and maintenance instructions and a complete parts list and recommended spare parts list. The O & M manuals shall be in compliance with the General Requirements.

END OF SECTION 462133 1/89

SECTION 462300 – GRIT REMOVAL AND HANDLING EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.
- B. References
 - 1. American Iron and Steel Institute (AISI).
 - 2. American National Standards Institute (ANSI).
 - 3. American Society for Testing Materials (ASTM).
 - 4. American Bearing Manufacturers Association (ABMA).
 - 5. American Gear Manufacturers Association (AGMA).
 - 6. National Electrical Manufacturers Association (NEMA).
 - 7. Underwriters Laboratory (UL).

1.2 DESCRIPTION

- A. Work described in this section includes furnishing all labor, equipment, materials, tools and incidentals required for a complete and operable installation and place into proper operation two (2) vortex grit removal systems, two (2) grit pumps, one (1) grit classifier as specified herein and shown on the Drawings.
- B. The manufacturer shall supply the equipment and the Contractor shall install the equipment and all pertinent accessories as shown on the Contract Drawings and directed by the Manufacturer.
- C. The vortex grit removal system shall be furnished complete with a cast iron, submersible gearhead, air bell, drive tube, radial flow X-impeller, self-priming grit pump, anchor bolts, controls for operation of the grit removal system and associated classifier, and all accessories and appurtenances specified or otherwise required for a complete and properly operating installation.
- D. The Vortex Grit removal system, grit slurry pumps, grit classifier and Controls shall be supplied by a single manufacturer to ensure compatibility and proper operation of the system.
- E. The manufacturer shall supply the Grit Equipment Control Panel. The Control Panel shall be manufactured in accordance with NEMA and UL standards. The Contractor shall install the Control Panel in accordance with all national and local electrical codes by a licensed electrician and shall provide a power supply to the panel.
- F. All equipment to be installed in the Headworks Area and shall be rated for Class I, Division 1, Hazardous locations. Equipment main control panel shall be located in a non-classified indoor area.
- G. Contractor shall be responsible for coordination of all related parts of the work. Contractor shall verify all structures, piping, wiring, and components are compatible. Contractor shall be

responsible for all structural and other alterations required to accommodate equipment differing in dimensions or other characteristics from these specifications and drawings.

- H. The contract drawings and specifications were prepared based on the named manufacturer in this item and the Contractor shall include in his base bid proposal, equipment by the specified manufacturer at the not to exceed price noted above.

1.3 SUMMARY OF WORK

- A. Manufacturer shall provide the grit slurry pumps, grit washer/classifier, discharge chute, motors, gear reducers, controls, and control panels, and auxiliary equipment including equipment supports as a complete integrated package to ensure proper coordination, compatibility, and operation of the system.
- B. Contractor shall construct Grit Tank (Chamber) No. 2 identical to the existing Grit Tank (Chamber) No. 1, provide new stop plates, effluent pipe connecting it to the existing effluent line as shown on the Contract Drawings. A slow rotating, fixed blade, X-Impeller shall be installed in both Grit Tanks. The Vortex Grit Tanks shall be capable of removing grit from screened wastewater and depositing the grit in a storage hopper.
- C. The grit pump shall convey the concentrated grit slurry collected in the Vortex Grit Tank hopper to the grit washer/classifier as shown on the Contract Drawings. Only one grit pump shall be in operation transferring grit from both Grit Tanks to the grit washer/classifier, and the second pump shall remain in standby mode. Grit slurry shall be pumped to a conical cyclone where the incoming flow gets separated.
- D. The cyclone shall be designed to separate the flow and deliver the majority of the incoming solids to the classifier. The underflow from the cyclone shall be deposited in the inlet hopper of the grit classifier where the grit then settles to the bottom. Free organics deposited in the hopper flow over the internal weir and into the launder box.
- E. Settled grit is transported up the inclined grit screw conveyor and discharged at through the grit chute.

1.4 QUALITY ASSURANCE

- A. In addition to requirements of these specifications, comply with manufacturer's instructions and recommendations for work.
- B. All equipment furnished under this Section shall be of a single manufacturer who has been regularly engaged in the design and manufacture of the specified equipment. All work performed under this section shall be in accordance with all approved trade practices and manufacturer's recommendations.
- C. The Manufacturer shall be successful in the experience of manufacture, operation, and servicing of Grit Removal Systems of type, size, quality, performance, and reliability equal to that specified for a period of not less than ten (10) years.
- D. The Manufacturer shall submit evidence of experience having supplied a minimum of ten (10) installations in North America of similar size to the proposed system.

- E. A single manufacturer shall provide all components including but not limited to the motors, gear reducers, and control panels as a complete integrated package to ensure proper coordination, compatibility, and operation of the system.
 - F. The grit system and control panel shall be factory assembled and tested to ensure proper design and satisfactory operation. Equipment shall be shipped in the minimal practical number of pieces for minimal field assembly by the Contractor.
 - G. Stainless steel portions of the equipment shall undergo a passivation process to ensure maximum resistance to corrosion. All stainless steel surfaces shall be thoroughly cleaned and glass bead-blasted to a minimum SSPC-SP-6 finish. The use of nitric and hydrofluoric acid passivation is not acceptable due to the negative impact these chemicals have on the environment.
 - H. All equipment shall be designed, fabricated, and assembled in accordance with recognized and acceptable engineering and shop practices. The fabrication shall be performed by the equipment manufacturer at the manufacturer's facility located within the continental USA; all welding and assembly shall be performed by direct employees of the manufacturer; each welder shall be certified in accordance with AWS or ASME. Welder certificates shall be provided to the Engineer upon request.
 - I. All welding shall be performed in accordance with American Welding Society (AWS) D1.1 Structural Welding Code.
 - J. All structural members of the equipment shall be designed for shock and vibratory loads.
 - K. Manufacturer shall warranty all equipment against faulty or inadequate design, improper assembly, defective workmanship or materials. Materials shall be suitable for the service conditions.
 - L. The vortex grit removal system shall have the Manufacturer's name, address, and product identification information on a corrosion resistant nameplate securely affixed to the equipment.
 - M. Manufacturer shall be ISO 9001:2015 certified and provide the Engineer with a copy of a valid certificate of registration. Equipment suppliers not utilizing ISO 9001 manufacturing facilities shall not be considered or approved for this project.
 - N. All control panels shall be fabricated and tested in the manufacturer's UL Authorized control panel shop. The equipment manufacturer shall supply a certificate of conformance confirming this requirement.
- 1.5 SUBMITTALS
- A. General: Submit the following in accordance with conditions of Contract and Division 1 Specification Sections.
 - B. Product Data: Contractor shall submit manufacturer's technical data and application instruction in accordance with the General and Supplementary Conditions and Division 1 Specifications and any additional information listed herein.
 - C. Shop Drawings:
 - 1. Dimensional drawings depicting all mechanical and electrical equipment dimensions and required overhead clearances.

2. Equipment layout, principal dimensions with related verifications required for installation including anchorage location.
 3. Equipment weight
 4. Electrical control drawings
 5. Drive motor data
 6. A list of recommended Spare Parts including any Special Tools required for routine maintenance of the equipment.
- D. Maintenance and Operating Instructions: Maintenance and Operation manuals shall completely describe the theory of the Grit Removal System, start-up, optimization and maintenance operations for the equipment to be furnished under this section, including:
1. As-Build Drawings
 2. Electrical diagrams
 3. Controls and Accessories
 4. Explanation of operating safety considerations
 5. Repair Parts and maintenance materials
 6. Troubleshooting data
 7. Repair data
- E. Spare Parts: Provide list of recommended Spare Parts
- F. Warranty: The Equipment Manufacturer shall submit a warranty certificate for review.

1.6 WARRANTY

- A. The manufacturer shall warrant all equipment furnished under this specification to be free from defects in material and workmanship for a period of three (3) years from the date of shipment.
- B. In the event a component fails to perform as specified or is proven defective in service during the warranty period, the Manufacturer shall repair or replace, at his discretion, such defective part. The cost of labor and all other expenses resulting from replacement or replacement of parts is not included.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Packing, Shipping, Handling and Unloading: Comply with Section 016600, Product Handling and Protection.
- B. The equipment shall be shipped in the largest assemblies possible permitted for transporting to minimize field assembly by the Contractor.
- C. Pack spare parts in containers bearing labels clearly designating contents and equipment for which they are intended.
- D. Equipment and materials damaged or not meeting the requirements of the reviewed Shop Drawings shall be immediately returned for replacement or repair.

- E. Carefully prepare for storage and label all equipment and materials after they have been inspected.
- F. Store all equipment and materials in a dry, covered, ventilated location and protect from harm according to the manufacturer's instructions.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. The vortex grit removal system(s) shall be in compliance with these specifications and plans and shall be supplied by the following manufacturer:
 - 1. Zima Corporation, Kusters Water Division
 - 2. Or Engineer approved equal.
- B. The design and layout shown on the drawings are based Zima Corporation, by Kusters Water Division. Other named or approved equals may differ with respect to the structure, electrical power, or controls. Changes in the structural, electrical, mechanical and plumbing requirements for the substitution shall be the responsibility of the CONTRACTOR wishing to make the substitution.

2.2 VORTEX GRIT CHAMBER

- A. General
 - 1. The vortex grit chambers shall be capable of removing grit from screened wastewater and depositing the grit in a storage hopper. No moving parts, subject to wear or stoppage, shall be installed in the grit storage hopper.
 - 2. The systems shall consist of a grit chamber designed to accept the incoming flow at a point tangential to the grit chamber that allows the flow to travel about the periphery of the chamber for a minimum of 270 degrees before being discharged.
 - 3. The grit is separated from the wastewater in the upper section of the chamber and collected in the lower storage hopper.
 - 4. A slow rotating, fixed blade, X-impeller shall allow the grit to settle in the storage hopper while rejecting organic matter.
 - 5. The X-impeller shall be mounted to a drive tube which is driven by a heavy-duty cast-iron gearhead. The gearhead input drive shall be a gear-reducer and an electric motor.
 - 6. Grit collected in the storage hopper shall be scoured and/or fluidized and then removed by a grit pump specifically designed for grit slurry applications.
 - 7. All drives, lubrication points, and bearings shall be readily accessible from walkways at the bridge/drive mounting level.
- B. Design Criteria:
 - 1. Number of Units: 2
 - 2. Peak Design Flow: 7 MGD per each unit
 - 3. Grit Chamber Diameter: 10'-0"

4.	Grit Storage Hopper Diameter:	5'-0"
5.	Grit Chamber Configuration:	270-degree
6.	Drive Tube Material:	304L Stainless Steel
7.	X-Impeller Material:	304L Stainless Steel
8.	Maximum X-Impeller Speed	12 RPM
9.	Suction Pipe:	4"Ø, Flanged
10.	Suction Pipe Material:	304L Stainless Steel
11.	Scour/Fluidizing Pipe	1.5"Ø, NPT, 304L Stainless Steel
12.	Scour/Fluidizing Water Flow Rate:	40-60 gpm @ 40 psig
13.	Motor Size	1 HP
14.	Ball Valve:	Bronze Body, SS Screen
15.	Solenoid Valve Material:	Bronze
16.	Strainer Material:	Bronze Body, SS Screen
17.	Operational Environment	Class 1, Div. 1
18.	Voltage	460V/3ph/60Hz
19.	Fasteners Material:	304 Stainless Steel

C. Performance and Design Requirements

1. Each Grit Chamber shall handle all flows up to the peak design flow of 7.0 MGD without loss of grit removal efficiency. The chamber shall remove grit with a specific gravity of 2.65 in the following percentages:
 - a. 95% of grit greater than 50 mesh.
 - b. 85% of grit greater than 70 mesh (200 microns)
 - c. 65% of grit greater than 100 mesh
2. The inlet channel to the grit chamber shall be as shown on the contract drawings and be designed to ensure that the grit does not settle in the inlet channel.
3. The floor of the upper chamber, 10 ft diameter, shall be sloped to enable the grit to fall by gravity to the storage hopper as shown in the Contract Drawings. Grit chambers designed without a sloped floor shall not be allowed for this project.
4. The storage hopper shall 5 ft diameter and shall have a 45-degree sloped conical bottom. Storage hoppers which require a floor plate that limits the open area at the transition from the upper chamber to the grit storage hopper are strictly prohibited.
5. The X-impeller shall be positioned immediately over the grit collection hopper to optimize the velocity in the grit chamber and maximize the removal of fecal and organic matter in the grit chamber.

D. Grit Chamber Components

1. Submersible Gearhead
 - a. The gearhead shall be comprised of a two-piece heavy-duty cast-iron base and upper housing securely bolted together to form a composite unit. Fabricated steel gear housings and upper plates are not acceptable. The base section shall support the precision bearing and shall be machined to prevent distortion of the bearing.

- b. The upper housing of the gearhead shall support the input gear reducer and motor. Housing shall be complete with tapped holes for lifting eyes and a machined flange for mounting the cover plate or grit suction pipe.
 - c. The entire gearhead shall be fully sealed, and the bottom opening shall be protected by an air-bell to prevent water from entering the gearbox in case of flooding. The air-bell shall be bolted and gasketed to the underside of the gearhead.
 - d. A nominal 21" precision turntable bearing shall be supplied for mounting the main spur gear. The turntable bearing shall have a minimum L₁₀ life of 20 years.
 - e. The main gear shall be a heavy-duty steel spur gear securely bolted to the precision main bearing and shall be driven by an alloy steel pinion gear. The main gear shall be machined to accept the mounting flange of the X-impeller drive tube. The pinion and spur gear shall have a minimum service factor of 7.0 or greater.
 - f. The pinion and main spur gear shall operate in a grease bath to prevent wear between the pinion and main spur gear.
 - g. The pinion gear shall be keyed to the output shaft of a heavy-duty helical gear reducer. The gear reducer shall be sized to provide the proper input power and torque to operate the gearhead and be rated for greater than the nominal horsepower of the drive motor.
 - h. The gear reducer shall have a cast iron housing with a minimum service factor of 1.2.
 - i. Gear reducer shall have ball or roller bearings throughout with all moving parts immersed in oil. Gears shall be of alloy steel with teeth precision ground and polished after casehardening. Shafts shall be of high strength alloy steel ground to required tolerances.
 - j. The gear reducer shall be driven by an inverter duty electric motor. The motor shall be UL rated for the operational environment as Class 1, Division 1. The motor shall be rated for a minimum 1 horsepower and 460V/3ph/60Hz, with a minimum service factor of 1.0.
 - k. The motor shall be rated at 40°C ambient with Class F insulation and shall have a Class B temperature rise at full load.
 - l. The complete gearhead unit shall be designed for extended maintenance-free operating periods based on 24-hour per day service. The gearhead shall be an in-house product of the manufacturer.
2. Drive Tube
- a. The drive tube shall be flange connected to the top of the main spur gear of the submersible gear head and shall pass through the gear and precision bearing, extending into the grit removal chamber for mounting the X-impeller.
 - b. The drive tube shall be 10-3/4" diameter and designed to provide less than 1/4" deflection under all flows.
 - c. Drive tube shall be manufactured from the 304L Stainless Steel.
3. X-Impeller
- a. The X-impeller shall be manufactured from 304L Stainless Steel.
 - b. The X-impeller shall have four (4) fixed vertical organics rejection/velocity control blades, mounted at an angle of 90 degrees to the horizontal. The blades shall be securely mounted to a split collar with stainless steel hardware. The split collar shall attach to the drive tube and allow vertical adjustment of the X-impeller. The X-impeller shall effectively remove organics and control the velocity in the grit chamber for optimum performance.
 - c. The open spacing between the X-impeller blades shall allow the organics displaced during scouring and/or fluidizing to pass upwards and out of the grit storage hopper,

while also allowing ease of access to the storage hopper without dismantling or removing the X-impeller assembly.

- d. Impellers that require a rotating or fixed floor cover plate which prevent easy access to the grit storage hopper are strictly prohibited.
- e. Impeller blades that do not have a fixed position that can become misaligned during operation and require a higher than 12 RPM speed are strictly prohibited.

2.3 GRIT SLURRY PUMP

A. General

- 1. Pumps shall be of a fully recessed impeller design, with the impeller mounted completely out of the flow path between pump inlet and outlet connections.
- 2. Pumps shall be of a heavy-duty construction, capable of handling large solids and abrasive particles.

B. Design Criteria

- 1. Quantity: 2, one per grit trap
- 2. Design Flow: 226 gpm, each pump
- 3. Design Head: 30 ft
- 4. Pump Speed: 1750 RPM
- 5. Maximum size solids passage: 4-inch sphere solids
- 6. Suction Connection Size: 6 inch
- 7. Discharge Connection Size: 4 inch
- 8. Impeller: Ni-Hard
- 9. Mechanical Seal: Carbon Ceramic
- 10. Motor Horsepower: 7.5 HP
- 11. Operational Environment: Class 1, Div. 1
- 12. Voltage: 460V/3ph/60Hz
- 13. Manufacturer: Hayward-Gordon, Torus XR Series, Model CR4-7

C. Pump Construction

- 1. Casing: The pump casing shall consist of a one-piece casting with integral suction and discharge nozzles plus a back plate with integral wear element. The casing shall allow removal of the complete rotating assembly, without disturbing suction and discharge piping. A 1" NPT female connection shall be provided for vacuum or liquid priming.
- 2. Impeller: Impellers shall be fully recessed out of the casing passage and must be a heavy-duty radial vane design. Impellers shall be fitted with full back pump out vanes to restrict flow behind the impeller and shall be keyed to the shaft and secured by a shrouded securing bolt and lock washer.
- 3. Wear Element: Pump impellers shall be fitted with a rear casing wear plate and integral radial wear element, which will protect the area behind and at the periphery of the impeller from the brunt of abrasive wear. The radial wear element will be of a tapered design to

promote flow of solids out of the impeller recess. Wear elements should be self-centering, with jacking screws provided to facilitate removal.

- a. The volute, impeller and wear elements shall be constructed from Super Ni-Hard ASTM A532 with a minimum hardness of 650 BHN for all applications containing grit – silica sand. Hardness measurement certificates to be provided confirming a minimum of 650 BHN for impeller, casing and wear plate and suction piece.
4. Shaft: A quill shaft assembly shall be provided that connects the motor shaft to the impeller.
5. Mechanical Seal: The pump shall be provided with a John Crane Type 21 mechanical seal with carbon vs. ceramic or tungsten carbide vs. tungsten carbide faces.
6. Pump and Motor Base: Pump is to be mounted vertically. Pumps can be provided with an optional pedestal and suction elbow or horizontal mounting.

2.4 GRIT CLASSIFIER

A. General

1. The grit classifier shall be a self-contained, auger driven grit classification system designed to receive pumped flow from a grit settling basin and positively separate free organic material from the deposited grit and transport the retained grit to the discharge point for deposition in a grit conveyor or collection dumpster. The grit classifier shall be designed to be fully automated.
2. Grit slurry will be pumped to a conical cyclone where the incoming flow will be separated. The cyclone will be designed to separate the flow and deliver the majority of the incoming solids to the classifier.
3. The underflow from the cyclone will be deposited in the inlet hopper of the grit classifier where the grit then settles to the bottom. Free organics deposited in the inlet hopper flow over the internal weir and into the launder box.
4. Settled grit is then transported up the inclined grit transportation trough by the grit screw and discharged at the grit discharge chute.
5. The Contractor shall be required to make any necessary modifications to the existing concrete, and to the operating floor, to accommodate the equipment furnished. The manufacturer shall ensure the furnished equipment will be acceptable for the area provided for the grit classification system.

B. Design Criteria

- | | |
|---------------------------------|--------------------------|
| 1. No. of Units: | 2 |
| 2. Maximum Pumped Flow | 250 gpm per cyclone |
| 3. Grit Screw Nominal Diameter: | 12 inch |
| 4. Grit Screw Pitch: | Half |
| 5. Grit Screw Nominal Length: | 10 ft |
| 6. Grit Screw Speed: | 12 RPM |
| 7. Grit Screw Capacity | 47 cf/hr |
| 8. Grit Screw Material: | Abrasion Resistant Steel |
| 9. Wear Shoe Material: | UHMWPE |

10.	Classifier Inclination:	25-degrees
11.	Grit Discharge Diameter:	10 inch
12.	Grit Discharge Height:	4.25 ft
13.	Overflow Outlet:	6 inch Flanged
14.	Overflow Discharge Height:	32 inch
15.	Hopper, Trough and Leg Material:	304L Stainless Steel
16.	Cover Material:	304L Stainless Steel
17.	Cover Type:	Solid
18.	Cyclone Model:	Krebs D10LB, Total of two (2) units
19.	Cyclone Body Material:	Steel & Aluminum
20.	Cyclone Liner Material:	Neoprene
21.	Cyclone Inlet:	4 inch, Flanged
22.	Cyclone Outlet:	6 inch, Flanged
23.	Motor Size:	1 HP
24.	Operational Environment:	Class 1, Div. 1
25.	Voltage	460V/3ph/60Hz
26.	Fasteners Material:	304 Stainless Steel
27.	Anchor Bolts Material:	304 Stainless Steel

C. Performance and Design Requirements

1. The classifier shall be capable of processing the maximum pumped flow of 250 gpm to each cyclone and up to 100 gpm of total underflow to the classifier.
2. The classifier screw shall be capable of transporting the full range of settled grit material efficiently to the discharge point. The transportation capacity of classifier screw shall be 47 cf/hr.
3. The grit classifier screw shall be a shafted design with a flight diameter which allows a grit bed to form in the bottom of the trough to prevent wearing of the trough.

D. Classifier Components

1. Cyclone
 - a. Two (2) cyclones shall be designed to accept quantities of grit and water pumped to the unit, each at a rate of 250 gpm and to operate at inlet pressures between 5 and 12 psig.
 - b. The inlet connection shall be provided with and 1-1/4" NPT connection for mounting of a pressure gauge. The unit shall be provided with a glycerin filled, diaphragm protected, pressure gauge and hand valve to monitor the inlet pressure of the grit cyclone.
 - c. The cyclone shall remove at least 95% of those solids retained on a 100 mesh sieve with specific gravity ≥ 2.65 .
 - d. The cyclone shall be provided with a heavy-duty volute feed chamber with cylindrical and conical sections of steel and aluminum material.

- e. Each section of the cyclone shall be provided with a fully replaceable liner of neoprene material. The cyclone must be constructed to allow each liner section to be replaced independently.
- f. The cyclone shall be provided with a vortex finder manufactured using Ni-Hard abrasion resistant material with a minimum Brinell hardness of 500.
- g. A fixed steel apex with neoprene rubber liner shall be provided.
- h. The discharge of the hydro-cyclones shall be fitted to a baffle box to accept the cyclone discharge. The baffle box shall be sized with a volume to properly dissipate the energy of the cyclone discharge and shall mount to the classifier inlet hopper. Baffle box shall be equipped with a hinged cover for inspection.
- i. The hydro-cyclone shall be supplied with a mounting frame for mounting the cyclone at an angle of 11.25° for discharge to the baffle box.

E. Inlet Hopper

1. The grit classifier inlet hopper shall be sized to provide the proper pool settling area and volume.
2. The inlet hopper shall be manufactured using minimum 1/4" thick 304L stainless steel material.
3. The inlet hopper shall include an adjustable overflow weir. The weir shall be designed to provide the proper retention time and discharge volume for the exiting flow and solids loading conditions.
4. The weir overflow shall discharge into a launder box fitted with a discharge pipe as specified in paragraph 2.4 B.

F. Screw Trough

1. The screw trough shall be manufactured using abrasion resistant steel material as with a minimum thickness of 1/4".
2. The trough shall have a diameter and side wall height to properly contain the conveyed material.
3. The trough shall be provided with a grit discharge of 12-inch diameter and at the elevation above the operating floor as specified herein and shown on the Drawings.
4. A 2" diameter drain connection shall be provided at the lowest point of the classifier trough.
5. The trough shall be supplied with support legs manufactured using 1/4" thick 304L Stainless Steel material to support the full static and dynamic load of the classifier.

G. Transport Screw

1. The screw shall be a shafted design and have a nominal 12-inch diameter, 10 ft length and half pitch, and constructed to CEMA standards. The screw shall be fabricated from abrasion resistant steel materials with a 3-1/2" O.D. minimum shaft diameter.
2. The upper end of the screw shall be coupled to a solid drive shaft with a flanged connection to enable the screw to be removed without disturbing the upper bearing or drive assembly.
3. The screw shall rotate between bearings within the transportation trough without the need for intermediate hanger bearings or wear bars.
4. The top bearing shall be a flanged roller type bearing designed to accommodate the radial loading from the screw and shall be provided with a grease nipple to permit greasing of the top bearing.

5. The lower bearing shall be a combination thrust and radial type arrangement housed outside the classifier trough for ease of service.
6. The bearing shall be comprised of an independent thrust bearing mounted to the end of the screw shaft capable of handling the full axial load created by the grit removal screw and a high performance metallic bushing to handle all radial loading.
7. Units submitted without an independent axial thrust bearing and/or a non-metallic lower bushing shall not be acceptable.
8. The bearing shall incorporate a triple seal arrangement to prevent the ingress of grit into the bearing housing.
9. The lower bearing shall be rigidly supported on the rear wall of the inlet hopper to ensure proper location of the transportation screw
10. A deflector plate shall be fitted over the bearing assembly to prevent grit from settling onto the bearing.
11. The lower bearing shall be grease lubricated and shall be greaseable using a standard grease gun.

H. Cover

1. The grit classifier shall be fitted with solid cover, made of 304L Stainless Steel material to fully enclose the screw trough and inlet hopper. The cover shall allow for visual inspection of the classifier trough and overflow launder.
2. Cover shall be supplied in separate panels for easy removal.

I. Drive Assembly

1. The classifier shall be driven by a heavy-duty, shaft-mounted helical worm gear reducer. The gear reducer shall be sized to provide the proper input power and torque to operate the screw and transport the required volume of grit. The gear reducer shall be rated for greater than the nominal horsepower of the drive motor.
2. The gear reducer shall be driven by a direct coupled TEFC electric motor. The motor shall be UL rated for the Class 1, Division 1 operational environment. The motor shall be rated for a minimum 1 Hp and 460V/3ph/60Hz, with a minimum service factor of 1.0.
3. Drive assemblies requiring V-belts shall not be acceptable.

2.5 CONTROLS

A. General

1. The contractor shall furnish, install and commission a Grit Screen Remote PLC Panel (MCP-125A), refer to electrical drawings for panel location. For exterior installation locations see Specification 409601. For interior installation locations see Specification 409602.
2. The contractor shall furnish, install and commission a separate Motor Control Panel (MCP-125B) for VFDs/ motor starters as outlined. Refer to electrical drawings for panel location and mounting requirements. The enclosure shall be NEMA 4X SS for exterior locations and NEMA 4 for interior locations. The motor control panel shall include but limited to: VFDs / motor starters as outlined, power supply, main 3 phase disconnect C/W front door handle, breakers, fuses, line reactors, terminals, etc. Provide adequate panel heating/cooling to meet panel interior components environmental requirements. All VFDs shall communicate

with Remote PLC Panel via Ethernet. Each VFD shall have a front door mounted HIM module. Each motor (VFD/Motor Starters) shall have a front door mounted HOA with green run indicator light and red fault indicator light. VFD manufacturer shall be AB Powerflex or approved equivalent.

3. All respective system field mounted devices and instrumentation shall be wired to the (MCP-125A/B) for a complete operating system as shown on the Drawings and as specified herein.
4. The contractor shall furnish, install and commission a Grit Removal Equipment Remote PLC Panel (MCP-150A), refer to electrical drawings for panel location. For exterior installation locations see Specification 409601. For interior installation locations see Specification 409602.
5. The contractor shall furnish, install and commission a separate Motor Control Panel (MCP-150B) for VFDs/ motor starters as outlined. Refer to electrical drawings for panel location and mounting requirements. The enclosure shall be NEMA 4X SS for exterior locations and Nema 4 for interior locations. The motor control panel shall include but limited to: VFDs / motor starters as outlined, power supply, main 3 phase disconnect C/W front door handle, breakers, fuses, line reactors, terminals, etc. Provide adequate panel heating/cooling to meet panel interior components environmental requirements. All VFDs shall communicate with Remote PLC Panel via Ethernet. Each VFD shall have a front door mounted HIM module. Each motor (VFD/Motor Starters) shall have a front door mounted HOA with green run indicator light and red fault indicator light. VFD manufacturer shall be AB Powerflex or approved equivalent.
6. All respective system field mounted devices and instrumentation shall be wired to the (MCP-150A/B) for a complete operating system as shown on the Drawings and as specified herein.
7. A separate local control station in an enclosure of NEMA 7 Cast Aluminum shall be provided for the Grit Chamber, Grit Pump and Grit Classifier. The local control stations shall include an emergency stop, red, mushroom head pushbutton, Hand/Off/Auto switches and all other operators as required for proper operation of the equipment specified.

B. Safety Features

1. If a power failure occurs while the equipment is running, operation shall resume when power is restored.
2. If a power failure occurs while the equipment is in a fault condition, the fault indicator shall reactivate when power is restored.
3. Short-circuit protection requires that a properly sized circuit breaker be provided by the Electrical Contractor.
4. Control reset shall be from the main control panel only.

C. Components

1. Controller
 - a. Allen Bradley CompactLogix PLC
 - b. Allen Bradley PanelView HMI
2. Operation Controls
 - a. Control Power: OFF/ON switch
 - b. Alarm reset: Pushbutton
 - c. Emergency Stop: Push to stop, pull to run pushbutton

3. Indicator Lights

	<u>X-Impeller</u>	<u>Grit Pump</u>	<u>Classifier</u>
Control Power ON	White pilot light	White pilot light	White pilot light
Running	Green pilot light	Green pilot light	Green pilot light
Fault	Red pilot light	Red pilot light	Red pilot light
Motor High Temp	Red pilot light	Red pilot light	Red pilot light

4. Dry Contacts

	<u>X-Impeller</u>	<u>Grit Pump</u>	<u>Classifier</u>
Running	Running	Running	Running
Fault	Fault	Fault	Fault
E-Stop	E-Stop	E-Stop	E-Stop

5. Local Station

	<u>X-Impeller</u>	<u>Grit Pump</u>	<u>Classifier</u>
Pushbutton		Cycle Start	-
Selector Switch	ON/OFF	HAND/OFF/AUTO	HAND/OFF/AUTO
Emergency Stop	E-Stop	E-Stop	E-Stop

6. Operation

- a. The X-impeller shall run continuously.
- b. When in Automatic mode, the grit removal system shall be started by the extraction cycle timer or the cycle start pushbutton.
- c. Classifier HAND Operation: When the control station HOA selector switch is in the HAND position, the classifier will run continuously. Turning the HOA selector switch to OFF will stop the unit.
- d. Classifier Automatic Operation: When the classifier selector switch is in the Auto position, the classifier will start on demand by a signal from the grit removal system control panel. After the start signal is removed, the classifier shall continue to run for the duration set in its off-delay timer to empty the unit of grit and then stop.

2.6 SHOP PAINT

- A. Stainless steel, aluminum and other corrosion-resistant surfaces shall not be coated. Carbon steel surfaces, not otherwise protected, shall be coated with a suitable non-hardening rust preventative compound.
- B. Auxiliary components, such as the grit pump, gearboxes, motors, and other manufactured components shall be furnished with the original Manufacturer's standard weather and corrosion-resistant coating.
- C. All surfaces to be painted (except for corrosion resistant materials) shall be bead blast cleaned to an SSPC-SP-6 finish, removing all dirt, rust, scale and foreign materials. Cleaned surfaces of the equipment shall be shop primed with a five (5) mil coat of Tnemec Series 161HS-1211 primer.
- D. Final touch-up and finish coating of the primed surfaces shall be the responsibility of the purchasing contractor, and shall be accomplished in the field. The purchasing contractor shall be responsible for ensuring that the finish coating is compatible with the above specified primer.

2.7 SPARE PARTS

- A. The following spare parts shall be provided:

1. Three (3) Fuses of each size and type used in the control panel.
2. One (1) Grit Pump Mechanical Seal
3. One (1) Set of O-rings and gaskets for grit pump

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Contractor shall verify all dimensions in the field to ensure compliance of equipment dimensions with the drawings. Contractor shall notify Engineer of any significant deviations.
- B. Installation of the equipment shall be in strict accordance with the contract documents and the Manufacturer's instructions and shop drawings. Manufacturer shall supply anchor bolts for the equipment. Contractors shall install the anchor bolts in accordance with the Manufacturer's recommendations.
- C. The equipment shall be installed in accordance with the manufacturer's recommendations.

3.2 INITIAL LUBRICATION

- A. All lubrication required for initial operation shall be furnished and applied in accordance with the manufacturer's recommendations.

3.3 INSPECTION, STARTUP AND TESTING

- A. Supplier shall furnish the services of a factory-trained Service Engineer for two (2) trips. One (1) trip of one (1) day for installation inspection services. One (1) trip of one (1) day for start-up, commissioning, and to provide operator training.
 1. Equipment shall not be energized, or "bumped", to check the electrical connection for motor rotation without installation inspection and the Service Engineer present.
 2. The Service Engineer shall make all necessary adjustments and settings to the controls.
 3. The Service Engineer shall demonstrate proper and sequential operation of the vortex grit removal system. The system shall be operated in both Automatic and Hand mode by the Service Engineer during the start-up and commissioning to demonstrate proper operation of the system.

3.4 OPERATION AND MAINTENANCE MANUALS

- A. Prior to or with the delivery of equipment, the manufacturer shall provide copies of an operation and maintenance manual including storage, installation, start-up, operating and maintenance instructions, and a complete parts list and recommended spare parts list. The O & M manuals shall be in compliance with the General Requirements.

END OF SECTION 462300

SECTION 462433 - SEWAGE GRINDER

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

1.2 DESCRIPTION OF WORK

- A. This section includes the furnishing and installation of four (2) sewage grinder units and all pertinent accessories, complete and in place, ready for service as shown on the Drawings and described in this section.
- B. The sewage grinder shall be furnished complete including structural steel and cast iron work, anchor and foundation bolts, motor, control panel, and all other accessories required for satisfactory operation.
- C. Equipment shall be designed and selected for continuous duty grinding of concentrated solids derived from the municipal wastewater industry. Grinders shall be suitable for grinding small particles of wood, industrial solvents, greases, detergents, rags, hair, and wipes, and organic particles in concentrations as great as 7 percent. The grinder fluids are expected to range in temperatures between 60 degrees F and 140 degrees F, and the pH may vary between 6 and 9.
- D. Contractor shall provide the pipe supports for the inline grinders, the grinders are not allowed to hang on the piping.
- E. All work performed under this section shall be in accordance with all approved trade practices and manufacturer's recommendations.
- F. All inline grinders shall be of the same manufacturer. Equipment Schedule is provided at the end of this section.

1.3 QUALITY ASSURANCE

- A. In addition to requirements of these specification, comply with manufacturer's instructions and recommendations for work.
- B. Manufacturer must have at least five (5) years of substantial experience in the manufacturing of two shafted grinders in the type of application specified herein.
- C. Grinders and motor controllers shall meet the requirements of the following industry standards:
 - 1. ASTM A536-84 - Standard Specification for Cast Iron Castings.
 - 2. ASTM A36 – Standard Specification for Carbon Steel Plate.
 - 3. AISI 4140 - Heat Treated Round Steel.

4. AISI 4130 - Heat Treated Alloy Steel.
5. National Electrical Manufacturer's Association Standards (NEMA).

1.4 SUBMITTALS

- A. Product Data: Submit manufacturer's technical data and application instructions.
- B. Provide full and complete shop drawings, catalog cuts, and other technical data to fully define the materials, equipment, and performance capabilities for each characteristic specified herein.
- C. Manufacturer's recommended installation instructions.
- D. Operation Maintenance Data
 1. For all units furnished under this Section, the Contractor shall submit one (1) electronic of Operation and Maintenance Manuals to include the following:
 - a. General - equipment function, description and normal and limiting operating characteristics.
 - b. Installation instructions - assembly procedures and alignment and adjustment procedures.
 - c. Operation instructions - startup procedures, normal operating conditions, emergency and normal shutdown procedure.
 - d. Lubrication and maintenance instructions which shall list all points to be greased or oiled; shall recommend type, grade, and temperature range of lubricants; and shall recommend frequency of lubrication.
 - e. Troubleshooting guide.
 - f. Parts list and predicted life of parts subject to wear.
 - g. Drawings - cross sectional view, assembly and wiring diagrams. Drawings shall include detailed parts lists with part numbers, instructions for ordering spare parts, and complete preventive maintenance instructions required to ensure satisfactory performance and longevity of the equipment.
 - h. Performance curves.
 - i. Instructions for adjustment, calibration and testing of selected electronic components or assemblies, normally considered replaceable by the manufacturer, whose performance is not ascertainable by visual inspection.
 - j. Service instruction for major components not manufactured by the equipment manufacturer, but which are supplied by him in accordance with these specifications. The incorporation of literature produced by the actual component manufacturer shall be acceptable.

1.5 WARRANTY

- A. The equipment shall be warranted to be free from defects in workmanship, design and materials for a period of two (2) years. If any part of the equipment should fail during the warranty period, it shall be replaced in the machine(s) and the unit(s) restored to service at no expense to the OWNER.

1.6 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. Deliver, handle, and store equipment in manufacturer's original undamaged shipping containers with tags and labels intact and legible.
- B. Store all equipment up off the ground, under cover, protected from weather and construction activities or other possible damage.

PART 2 - PRODUCTS

2.1 MANUFACTURER

- A. Subject to compliance with specified requirements, supply the sewage grinders from one of the following manufacturers:
 - 1. JWC Environmental
 - 2. Moyno TR Muncher
 - 3. Or Engineer Approved equal.

2.2 MATERIAL

- A. Grinder shall be of corrosion resistant materials compatible so as to resist pitting due to cavitation or corrosion due to galvanic action.
 - 1. Casting: Cast iron ASTM A48 GG30, 20-26 Rockwell "C".
 - 2. Wear Plates and Counter Blades: Hardox Carbon Steel, 43 Rockwell "C".
 - 3. Cutters: High Wear Resistant Steel, Nitrated, 40-45 Rockwell "C".
 - 4. Shafts: Alloy Steel, AISI 4140, 2.32-inch diameter, tensile strength rating no less than 149,000 psi.

2.3 EQUIPMENT

- A. General:
 - 1. The sewage grinders shall be a two-shaft design and be capable of continuous operation, processing wet or dry.
 - 2. Two-shaft design shall consist of two parallel shafts equipped with monolithic cutter assemblies positioned on the shaft to form a helical pattern. If multiple cutter packages are used, O-rings shall be incorporated between each cutter package. Individual cutter and spacers will not be acceptable. The two shafts shall counter-rotate with the driven shaft operating at different speed than the speed of the drive shaft.
- B. Components:
 - 1. Grinder gearbox housings shall be cast of ASTM A48 cast iron.
 - 2. The bottom end housing shall be manufactured of carbon steel and bolted together to be field changeable on demand.
 - 3. Grinder housing segments shall be manufactured of 1018 mild steel, bolted together.
 - 4. Flange connections shall be integrated as part of the one-piece grinder body.
 - 5. The top and bottom counter blade plates shall be manufactured of Hardox, minimum hardness of 43 Rockwell C (500 Brinell) and provide counter cutting action to protect against buildup in the top and bottom of the grinder.

6. Grinder drive and driven shafts shall be made of 4140 alloy heat-treated round steel with a tensile strength rating of not less than 149,000 psi. Each shaft diameter shall be a minimum of 2.32 inches.
7. Cutters and Blades
 - a. Cutting stack shall be a nominal height of 5.51 inches.
 - b. Cutter shall be manufactured from a monolithic assembly constructed from a solid block of alloy steel surface ground to a blade thickness of .37-inches +0.000/-0.001.
 - c. Cutters shall be heat treated to produce a hardness of 60-65 Rockwell "C".
 - d. Cutters shall be nitrated for high corrosion resistance.
 - e. Cutters shall have 8 cam shaped teeth.
 - f. Cutter tooth height shall not be greater than 1/2-inch above the root diameter of the cutter.
 - g. Cutter assembly OD shall be 6.54-inches minimum. Spacer shall be cut into the monolithic cutter and shall have a smooth outside diameter with no tooth profiles. Designs without a single monolithic cutter assembly shall not be acceptable.
8. Bearings and Seals:
 - a. The radial and axial loads of the shafts shall be borne by oversized radial spherical roller bearings on upper and deep groove ball bearings on lower end. The bearings shall be protected by a single cartridge mechanical seal. Seal face materials must be a minimum of Chrome Oxide vs Duronit, not requiring an external flush, but in a static bath of oil. The mechanical seal shall be rated at 90 psi continuous duty by the seal manufacturer. The bearings and seals shall be housed in a replaceable cartridge that supports and aligns the bearings and seals, as well as protects the shafts and end housings. The seal elements shall be independent of the stack height. The seal shall meet required pressure rating regardless of cutter stack fit. The seal and bearing cartridge shall provide protection against axial loading on shafts and bearings during shaft detection. O-rings shall be made of Buna-N elastomers.
 - b. Grinders that require lower bearings shall not be acceptable.
9. Electric Motor & Reducer:
 - a. The grinder gearbox shall be a low speed, high-torque parallel shaft gearbox manufactured by Nord Gear. Maximum motor speed shall not exceed 1800 rpm and should provide a minimum of 10% reserve HP as evidenced by specific requirements at maximum design.
 - b. All motors shall be built in accordance with latest NEMA, IEEE, ANSI and AFBMA standards where applicable.
 - c. Motor shall be TEFC with a minimum service factor of 1.15.
 - d. Motors shall conform to all requirements stipulated in the motor section of this specification.
 - e. The motors supplied shall be specifically designed for inverter duty to allow for the potential of future variable frequency drives. The motors shall be compatible with the grinders provided by the MANUFACTURER. The gear speed reducer shall be Nord parallel shaft geared type of reducer with "Heavy Shock" load classification. The drive shaft of the grinder shall be directly coupled with the reducer without use of a coupling.
 - f. Required running torque per horsepower:

- 1) At momentary load peaks: 4,756 in-lbs.

2.4 MOTOR CONTROLLERS

A. General:

1. Controller shall be the suppliers UL listed standard and shall provide independent control of the grinder.
2. The controller shall be equipped with HAND-OFF/RESET-AUTO three-position selector switch. In OFF/RESET the grinder shall not run. In HAND the grinder shall run. In AUTO the grinder “Start” and “Stop” shall be controlled by a remotely located dry contact.
3. When a grinder jam condition occurs, while running in either the HAND or AUTO mode, the motor controller shall stop the grinder and reverse its rotation to clear the obstruction. If the jam condition still exists, the controller shall go through five additional reversing cycles within 45 seconds before signaling a grinder overload condition. When a grinder overload condition occurs, the controller shall shut the grinder off and activate a “Fail” indication.
4. If the grinder is stopped due to a “Fail” condition and a power failure occurs, the fail indicator shall reactivate when power is restored.
5. Controller reset shall be from local panel controls only.
6. The controller shall have indicator lights for POWER ON, RUN and FAIL conditions.
7. The controller shall provide overcurrent protection for the motor through an overload relay mounted directly on the contactor.
8. The controller shall be rated 3-HP, 460V volts, 3 phase, 60 HZ.
9. Short circuit protection requires that a properly sized circuit breaker or fuses be installed by others.

B. Components:

1. Enclosure
 - a. Enclosures shall be NEMA 4X, fabricated of polycarbonate reinforced polyester resins for wall mounting. Doors shall have hinges and corrosion resistant latches.
 - b. Enclosure shall house the control devices, relays, terminal blocks, and grinder reversing motor starter.
2. Control Devices
 - a. Pilot devices shall be mounted on the enclosure front panel.
 - b. Indicators shall be LED type lights. Lamps and the selector switch shall be heavy duty NEMA 4 Type.
 - c. Two normally open status contacts shall be provided. One for a RUN signal and one for FAIL signal. The contacts shall be rated at 2-Amp, 240-VAC, resistive load.
 - d. Control transformer shall be protected by two primary fuses and one secondary fuse. The 120-volt secondary shall have one leg grounded.
3. Motor Starter
 - a. A reversing contactor type motor starter shall be provided for the motor.
 - b. Forward and reverse contactors on the starter shall have both mechanical and electrical interlocks.

- c. The overload (OL) relay shall be adjustable so that the range selected includes the FLA (full load amperes) rating and service factor.

2.5 PAINTING

- A. Shop Painting:
- B. Protect all exposed ferrous metals with a minimum of one coat of shop primer. Apply an additional coat of two-part epoxy to motors, pumps, gear boxes, and other similar equipment.
- C. All surfaces must be dry, clean, and free of rust, scale, oil and grease. Clean steel surfaces by pickling or blasting to a minimum of SSPC-SP6.
- D. Surface preparation, application and minimum DFT millage to be as per the paint manufactures published recommendation.
- E. Painting shall be in accordance with the manufacturer standards.
- F. Field Panting

2.6 SPARE PARTS

- A. Provide the following spare parts for each unit:
 - 1. One (1) complete gaskets & O-ring set.
 - 2. One (1) set of mechanical seals.
 - 3. One (1) set of monolithic cutters.
- B. Grinder spare parts shall be packaged in containers suitable for long term storage and shall bear labels clearly designating the contents and the equipment for which they are intended.

PART 3 - EXECUTION

3.1 FACTORY TESTING

- A. Each grinder and motor controller shall be factory tested to ensure satisfactory operation. All in-line units shall have a hydrostatic test conducted at the factory.

3.2 OPERATION AND MAINTENANCE MANUALS

- A. Prior to or with the delivery of equipment, the manufacturer shall provide copies of an operation and maintenance manual including storage, installation, start-up, operating and maintenance instructions, and a complete parts list and recommended spare parts list. The Operation and Maintenance Manuals shall be in compliance with the General Requirements.

3.3 INSTALLATION

- A. Grinder and motor controller shall be installed in accordance with the manufacturer(s) installation instructions.

3.4 FIELD QUALITY CONTROL

- A. Provide the services of a factory trained representative to check initial installation and to place each grinder in service. Factory representative shall have complete knowledge of proper installation, operation, and maintenance of equipment supplied. Representative shall inspect the final installation and supervise a start-up test of the equipment.
- B. After completion of the installation, the equipment shall be tested by the Contractor in the presence of the Engineer under actual operating conditions. The test shall be conducted under the supervision of the manufacturer's technical representative.

3.5 PAINTING

- A. All rust, scale, dirt or other foreign matter shall be removed by solvent cleaning, wire brushing, short blasting or other standard commercial cleaning procedure.
- B. Grinders shall be field painted and finish coated in accordance with the Owner's Color Coding and Process System Identification color with the standard commercial finish per Specification Section 099700 Special Coating.

3.6 LUBRICATION

- A. The equipment shall be lubricated by the Contractor when erected and he shall furnish the necessary oil and grease for one (1) year of operation. The grades of oil and grease shall be in accordance with the recommendations of the manufacturer.

3.7 MANUFACTURER'S SERVICES

- A. The equipment manufacturer shall provide a minimum one (1) day service for technical representative to inspect the equipment after installation, supervise initial operation and testing, and instruct Owner's personnel in its use.
- B. Minimum Service Requirements:
 - 1. Installation: As required for proper installation.
 - 2. Operator training: 2 hours on-site training.

3.8 GRINDER SCHEDULE

A. Sludge Transfer Grinder

- 1. Location - Basement of Sludge Transfer Building
- 2. Service - Aerobically digested Waste Activated Sludge from Sludge Holding Tanks 1-3 to Sludge Wet Well
- 3. Quantity - 2
- 4. Design Flow - 300 gpm

- 5. Solids Concentration – 6%
- 6. Max Motor Size: - 3 HP
- 7. Inlet/Outlet - 6" 125 # FF ANSI per ASME 16.5B

B. Sludge Dewatering Grinder (located in the Sludge Transport Electrical Building)

- 1. Location - Sludge Transport / Electrical Building
- 2. Service - Sludge feed from the Sludge Wet Well to
Dewatering Equipment
- 3. Quantity - 2
- 4. Design Flow - 150 gpm
- 5. Solids Concentration - 6%
- 6. Max Motor Size: - 3 HP
- 7. Inlet/Outlet - 6" 125 # FF ANSI per ASME 16.5B

END OF SECTION 462433

SECTION 463333 – POLYMER BLENDING AND FEED EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.
- B. The following equipment and related work are specified and furnished under other items:
 - 1. Section 030000 – Concrete
 - 2. Section 055800 – Metal Fabrications
 - 3. Section 099700 – Special Coatings
 - 4. Division 26 – Electrical
 - 5. Section 467331 – Sludge Dewatering

1.2 SUMMARY

- A. This section includes furnishing, installing, and placing into successful operation one (1) complete polymer blending system with progressive cavity pump, motors and controls, including all integral piping, valves, fitting, pipe supports, special equipment and appurtenances in accordance with this specification, including all incidental work necessary to make it complete, satisfactory and ready for operation.
- B. The polymer dilution and feed system shall be capable of effectively activating and fully blending with water a homogenous polymer solution.
- C. Polymer blending system shall operate in conjunction with sludge dewatering equipment as specified in Section 467331– Multi-Disc Screw Press. All equipment shall be delivered as part of the complete dewatering skid mounted system.

1.3 SYSTEM DESCRIPTION

- A. The polymer dilution and feed system shall be capable of effectively activating and fully blending with water a homogenous polymer solution ranging from 0.1 to 2% concentration based on neat emulsion polymer with active contents of 30-50%.
- B. Design Requirements for the Polymer Feed System:
 - 1. Polymer shall be drawn from a tote located next to polymer feed system, as shown on the Drawings.
 - 2. Polymer Type: Emulsion.
 - 3. Polymer Activity (percent active): 30 to 50.
 - 4. Solution Concentration Range: 0.1% to 2% based on neat polymer.
 - 5. Solution Concentration Design Point: 0.5% based on neat polymer.

Neat Polymer Flow Range gph	Dilution Water Range gph
0.5–10	120–1200

- C. Performance Requirements: Polymer Feed System shall be capable of supplying between 0.5 and 10 gallons per hour liquid emulsion polymer, with the entire flow passing through the preparation unit. Following preparation and mixing, the polymer solution leaving the mixer shall be ready to feed the dewatering volute press unit.

1.4 SUBMITTALS

- A. Product Data: Provide unit capacities, projected effluent values, loading parameters, design parameters, oxygen requirements, dimensions, etc.
- B. Shop Drawings:
 - 1. Submit detailed specifications and shop drawings with both shaded isometric and orthogonal views of the proposed system, including dimensions and weights.
 - 2. Submit wiring, control schematics, and control logic diagrams for all electrical and control components furnished.
 - 3. Factory testing documentation.
- C. Provide detailed Operations and Maintenance Manuals including storage, installation start-up and operating instructions. Provide safety precautions and warnings of all hazards operating equipment.

1.5 QUALITY ASSURANCE

- A. In addition to requirements of these specifications, comply with Manufacturer's instructions and recommendations for work.
- B. All equipment included in this section shall be furnished by a single supplier who shall be responsible for the design, coordination, and the satisfactory operation of the system.
- C. Provide evidence of at least fifteen (15) years demonstrable experience in the design and manufacture of polymer blending systems. The Supplier shall have at least twenty-five (25) polymer feed systems operating successfully for at least five (5) years in North America at municipal wastewater treatment plants that were designed and furnished under the Supplier's own name.
- D. Prior shipment the system shall be inspected for quality of construction verifying all fasteners and fittings are tight, all wires are secure and connections whisker-free.
- E. The complete system shall be fully factory tested prior to shipment. Testing shall include setting and verification of all instrumentation and sensors per the design requirements of the application; pressure testing all plumbing systems for a minimum of one hour at 100 psi. If leaks are found they shall be fixed and a new test shall be conducted for one hour at 100 psi until the plumbing system is verified to be leak free: verification of system design flow rates, and complete function simulation of operation.

1.6 DELIVERY AND STORAGE

- A. The equipment shall be shipped in a new, high quality completely enclosed weatherproof wooden crate.

- B. The crate shall include a shock sensor to warn of equipment mishandling during shipment.

1.7 WARRANTY

- A. The manufacturer shall warranty the equipment furnished under this section to be free from defects in material and workmanship for a period of twelve (12) months after the equipment was first placed into operation at the jobsite or eighteen (18) months after the equipment was first delivered to site, whichever date occurs first. Any warranted material defects found to exist shall be corrected (repaired or replaced) at no cost to the Owner.
- B. The mixing chamber shall be warranted for the life of the system against plugging for any reason.

1.8 SPARE PARTS

- A. Provide the following Spare Parts:
 1. One (1) progressive cavity pump stator
 2. One (1) progressive cavity pump shaft seal

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Acceptable Manufacturers:
 1. VeloDyne – Velocity Dynamics of Louisville, CO
 2. Or approved equal
- B. This listed equipment is part of the Base Bid and shall be considered as establishing the type, function, appearance, and quality required as defined in the General Conditions
- C. The drawings and specifications were prepared based on Velodyne. CONTRACTOR shall include in the Bid and shall be responsible for the cost of any changes, including engineering changes, to accommodate the other Base Bid equipment including but not limited to structural, mechanical, and electrical work.
- D. CONTRACTOR may provide Alternative Bids for equipment from other manufacturers by writing their name into the blank(s) provided on the Bid form. CONTRACTOR shall comply with all provisions regarding substitute items and shall include in the Bid and be responsible for the cost of any changes to accommodate substitute equipment including, but not limited to, structural, mechanical, and electrical work. CONTRACTOR shall also pay costs of engineering services for review of substitutes and for revisions of drawings and/or specifications by ENGINEER to accommodate substitutes.

2.2 EQUIPMENT PERFORMANCE

- A. The polymer-blending system shall be a complete package that automatically dilutes, activates and feeds liquid polymer and water. Blenders shall instantaneously invert neat polymer into solution, producing a thoroughly diluted and completed activated homogenous blend, free of “fish-eyes” and unblended polymer.

- B. The polymer blending and feed equipment shall be provided to meet the following performance and design requirements:
1. Polymer Type: Liquid emulsion (30-75 percent active)
 2. Neat Polymer Feed Rate: 0.5 to 10 gph
 3. Diluted Polymer Concentration: 0.1-1% of Total Active
 4. Dilution Water Flow Range: 120-1200 gph at 50 psi minimum.

2.3 MULTIZONE MIXING CHAMBER

- A. To provide control and versatility to optimize the performance of the wide range of polymers available and to optimize system reliability, a multi-stage hydro-mechanical polymer blending technology shall be provided with both a non-mechanical and mechanical mixing stage:
1. Non-Mechanical Stage: To optimize reliability, the device shall be capable of activating and blending polymer based on plant water pressure alone of 30 psi or greater. Polymer shall be injected directly into a water jet by means of an injection quill positioned such that the non-mechanical mixing energy is no way diminished prior to polymer and water contact. The non-mechanical zone shall be designed such that the velocity of the mixing energy-producing water jet is maintained or increases as flow decreases. Polymer activation efficiency shall be consistent over the dilution water range.
 2. Hydro-Mechanical Mixing Stage: To provide optimal polymer performance under all operating conditions and to provide total control over mixing energy, in addition to the non-mechanical mixing stage the device shall be capable of producing its mixing energy independent of plant water pressure through a variable intensity, controllable stainless steel hydro-mechanical mixer. The mixing impeller shall be fully controllable and capable of inducing ultra-high, non-damaging recirculation through the impeller. The polymer mixing impeller shall be designed to produce both axial and radial flow to optimize mixing effectiveness and to effectively induce high, non-damaging mixing energy over the systems full flow range.
 3. To prevent polymer build-up, the mixing chamber shall maintain high velocity in the entire chamber – at no time shall there be low velocity within any portion of the mixing chamber.
- B. Both mechanical and non-mechanical mixing zones shall be clear polycarbonate to view the mixing action and blending effectiveness. Acrylic chambers prone to becoming brittle over time and cracking, or opaque pipe shall not be acceptable.
- C. The mixing chamber shall have a maximum rated pressure of 100 psi. Provide a 316 stainless steel, adjustable-range pressure relief valve on mixing chamber set at 75 psi.
- D. Impeller shall be driven by a 0.5-hp, 90-volt DC, 5.0 FLA, washdown-duty, TENV motor. Impeller speed shall be minimum 1,750 rpm. Motor shall be direct coupled to impeller shaft. The speed of the mixer shall be controlled by an SCR speed controller mounted in the polymer feed motor control panel. Motors mounted under the mixing chamber where seal failure or leaks can damage the motor shall not be acceptable.
- E. The mixer drive shaft shall be sealed by a mechanical seal which shall have an integrally mounted and factory plumbed seal flush. A drain port behind the seal shall be provided in the mixing chamber to drain the polymer solution in case of a seal failure. The seal shall be easily accessible for replacement. All bearings shall be external from the mixing chamber.

- F. Neat Polymer Check Valve: Provide a neat polymer check valve specifically designed to isolate neat polymer from dilution water. The valve shall be designed with an open, unobstructed path to the valve seat. Minimum area to valve seat shall be 3/16 inch. The valve body shall be constructed of Teflon with Viton seals, and the ball shall be stainless steel. The valve shall be readily accessible for cleaning and shall be easily disassembled. Conventional check valves and/or check valves that are installed inside the mixing chamber, or which require mixing chamber disassembly for servicing will not be accepted.
- G. Dilution Water Control
 - 1. If Manufacturer requires two-stream dilution control, dilution water shall be split into two streams. Primary water flow shall supply the mixing chamber. Secondary water flow shall be used to post dilute the activated polymer stream.
 - 2. Flow indicators and flow control valves shall be provided for the dilution water stream:
 - a. The dilution water flow rate shall be monitored by a Rotameter flow meter having the range of 120-1200 gph. Unions of flanges shall be provided on the flow meter to allow easy removal for cleaning.
 - 3. Provide a factory installed and pre-wired 120 VAC electric solenoid valve for on/off control of dilution water flow. Solenoid valve body shall be 316L SS.
 - 4. A differential pressure type low water differential pressure alarm with 120-volt rated contacts shall be provided. The switch shall be adjustable between 9 and 60 psig. Static working pressure shall be at least 150 psi. The pressure switch shall be as manufactured by Ashcroft, or equal.
 - 5. Dilution water and solution output connections shall be 316 stainless steel unions connected to chassis.

2.4 DILUTION WATER INLET MANIFOLD

- A. The dilution water inlet assembly shall include an inlet fitting, a factory installed and pre-wired 120 VAC, NEMA 4X dilution water solenoid valve, Rotameter-type flow meter, stainless steel liquid-filled dilution water inlet pressure gauge, and 316L stainless steel water control valves. Plastic control valves shall not be acceptable. Manufacturer shall provide valves in accordance with Division 40.

2.5 NEAT POLYMER METERING PUMP (PROGRESSING CAVITY)

- A. The system shall have one (1) neat polymer metering pump integrally mounted on the system's skid.
 - 1. The neat polymer metering pump shall be progressing cavity-type pump, constructed of 316 stainless steel rotor and fluoroelastomer stator. The sft seal shall be a lip seal type riding on a ceramic sleeve.
 - 2. The pump shall have a minimum continuous output range of 0.5 to 10 gph.
 - 3. The pump shall contain a minimum of four stages to minimize slip.
 - 4. The pump shall be mounted to the skid frame with a 304 stainless steel bracket that positions the pump suction no more than 18 inches off the base to maintain ideal pump suction conditions.
 - 5. A 120VAC SCR variable speed controller with 90-vold DC, 5.0 FLA, 1/2 HP close-coupled, washdown-duty, TENV motor. Maximum pump shaft speed shall be 545 rpm. The speed of the pump shall be controlled by a SCR speed controller mounted in the polymer feed motor control panel.

- B. Provide a calibration cylinder with one full port PVC ball valves having Viton O-rings. The column shall be calibrated for a one-minute draw-down at maximum pump rate and read in GPH and milliliters. The calibration column shall be rigidly mounted to the systems frame with a minimum of two heavy duty brackets. Mounting the calibration to the neat polymer inlet piping shall not be acceptable. Provide a breather plug in the top of the calibration column designed to allow adequate displacement of air during calibration while preventing water or other foreign material from entering the calibration column.
- C. Provide a thermal type loss of polymer flow sensor.
- D. Pump shall be Moyno Industrial Products, a Division of Robbins & Meyers, Inc., Seepex, or equal.
- E. Pump shall allow for manual adjustment of the pumping capacity.
- F. Provide a factory installed and pre-wired high-pressure switch on the discharge of the pump. Pressure switch shall be Square D Type GAW, or equal. High pressure setting shall be set by manufacturer. The high discharge pressure switch shall shut down the pump in the event of high discharge pressure (On and Remote modes). Manual reset shall be required to restart the pump.
- G. Spare Parts:
 - 1. The following spare parts shall be supplied for the progressive cavity pump:
 - a. One (1) Stator
 - b. One (1) Rotor
 - 2. These parts shall be identified, prepared, and packed for long-term storage.

2.6 SOLUTION DISCHARGE ASSEMBLY

- A. Provide a 2-1/2-inch stainless steel liquid filled pressure gauge to monitor system discharge pressure.
- B. Provide a PVC ball-type check valve to prevent backflow. Valve shall be sized for total solution flow of the system.

2.7 FRAME/SKID

- A. The system's frame shall be of rugged 304 stainless steel construction. All pipe supports shall be stainless steel. Piping and valves shall be mounted with rigid pipe clamps.
- B. All components of each dilution/feed assembly, including pump, drive, control devices and instruments, and local control panel shall be factory pre-plumbed and pre-wired.

2.8 CONTROL PANEL

- A. The contractor shall furnish, install and commission a Remote PLC Panel (MCP-1025A), refer to electrical drawings for panel location. For exterior installation locations see Specification 409601. For interior installation locations see Specification 409602.
- B. The contractor shall furnish, install and commission a separate Motor Control Panel (MCP-1025B, MCP-1025C) for VFDs/ motor starters as outlined. Refer to electrical drawings for panel location and mounting requirements. The enclosure shall be NEMA 4X SS for exterior locations and Nema

4 for interior locations. The motor control panel shall include but limited to: VFDs / motor starters as outlined, power supply, main 3 phase disconnect C/W front door handle, breakers, fuses, line reactors, terminals, etc. Provide adequate panel heating/cooling to meet panel interior components environmental requirements. All VFDs shall communicate with Remote PLC Panel via Ethernet. Each VFD shall have a front door mounted HIM module. Each motor (VFD/Motor Starters) shall have a front door mounted HOA with green run indicator light and red fault indicator light. VFD manufacturer shall be AB Powerflex or approved equivalent.

- C. Provide a NEMA 4X, FRP control panel factory mounted to the polymer system skid and pre-wired to all skid motors and controls. The control panel shall have all logic controllers, SCR motor controllers, digital displays, potentiometers, switches, lights, relays, and other control devices as required for a functioning system.
- D. Polymer system control panel shall have the following devices on the front of the control panel enclosure:
 - 1. System On-Off/Reset-Remote selector switch.
 - 2. Manual mixer speed control potentiometer.
 - 3. Manual polymer metering pump speed potentiometer (ten turn).
 - 4. Polymer metering pump flow display (signal based on pump speed).
 - 5. Green power on indicating light.
 - 6. Red "low water differential pressure" alarm indicating light.
 - 7. Red "low polymer flow" alarm indicating light.
 - 8. Red "high polymer discharge pressure" indicating light.
- E. Polymer system control panel shall receive the following inputs from the Dewatering Press Motor Control Panel (MCP-1025B):
 - 1. Polymer system start/stop command (discrete dry contact).
 - 2. Polymer metering pump pacing speed signal (analog 4-20mA).
- F. Polymer system control panel shall provide the following outputs to the Volute Press Motor Control Panel (MCP-1025C):
 - 1. Polymer system running (discrete dry contract).
 - 2. Polymer system "in remote" (discrete dry contact).
 - 3. Polymer system common alarm (discrete dry contact) active when any system alarm is active.
 - 4. Polymer system high discharge pressure alarm (discrete dry contact).
 - 5. Polymer metering pump speed feedback (analog, 4-20mA).
- G. Control panel shall accept 120-volt AC, single-phase, 20-amp hardwired branch circuit power. Provide a main control panel circuit breaker disconnect and a dedicated circuit breaker for each motor.
- H. All conduit and wiring from the polymer system control panel to the associated polymer system devices shall be factory-prewired or provided by Polymer Feed Equipment Supplier.
- I. Electrical devices, terminal blocks, selector switches, indicating lights, etc. for this equipment are specified under Section 40 70 00-Controls and Instrumentation Equipment of these specifications.

2.9 PIPING AND VALVES

- A. All piping and valves shall conform to Division 40. Piping and fittings shall be Schedule 80 PVC. Solenoid valves shall be 316 or 316L stainless steel.
- B. CONTRACTOR shall provide strainer and all unions, piping, fittings, and appurtenances to connect to emulsion polymer tote, as shown on the Drawings, including 2-inch NPT connection, isolation ball valves, 1-inch quick-disconnect adapter, vent connection, and 20 feet of 1-inch clear, braided, PVC tubing.

2.10 SPARE PARTS

- A. CONTRACTOR shall provide, along with the shop drawings, a list of the manufacturer's recommended spare parts for the specified equipment. The list shall include a description of each spare part, current pricing, and expected delivery time for each part. No spare parts shall be provided by CONTRACTOR/manufacturer as part of this Contract.
- B. Manufacturer to supply following spare parts:
 - 1. One (1) stator for the neat polymer progressive cavity pump
 - 2. One (1) rotor for the neat polymer progressive cavity pump
- C. These parts shall be identified, prepared, and packed for long-term storage.

2.11 FINISHES

- A. It is the intent of these specifications that equipment, support and accessories be furnished factory shop-primed and finish-painted. Equipment and appurtenances shall be prepared in accordance with commercial grade SSPC specifications No. 6. Priming and finish painting shall be as recommended by manufacturer and shall be suitable for a corrosive atmosphere. Touchup paint shall be provided by manufacturer.

2.12 ANCHOR BOLTS

- A. Provide all anchor bolts required for equipment furnished. Anchor bolts shall be 316 stainless steel and shall be of ample strength for intended service. Provide anchor bolts in accordance with Division 5.

PART 3 - EXECUTION

3.1 GENERAL

- A. Refer to requirements specified in Division 01 for equipment installation, quality control, testing, supervision, start-up, and operator training.
- B. The complete system shall be fully factory tested prior to shipment. Testing shall include setting and verification of all instrumentation and sensors; pressure testing all skid-mounted plumbing systems as specified in Division 40. If leaks are found, they shall be fixed and a new test shall be conducted until the plumbing system is verified to be leak free. The system shall undergo factory verification of system design flow rates and complete functional of operation. Documentation of each test shall be maintained and provided to ENGINEER as a part of shop drawing review.

- C. Refer to Section 467331–Volute Dewatering Press for startup and performance testing requirements of the dewatering process, including performance of Polymer Blending and Feed Equipment.

END OF SECTION 463333

SECTION 464324 – SECONDARY CLARIFIER TANKS MECHANISM

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.
- B. Standard References
 - 1. ASTM – American Society of Testing Materials
 - a. A 36 - Structural Steel Specifications
 - b. A 48 - Cast Iron Specifications
 - c. A 83C - Steel Plate Specifications
 - d. A 123/A 123M -Standard Specification for Zinc (Hot Dip Galvanized) Coatings on Iron and Steel Products.
 - e. A 148/A 148M - Standard Specification for Steel Castings, High Strength, for Structural Purposes.
 - f. A 276 - Standard Specification for Stainless Steel Bars and Shapes.
 - g. A 283C - Steel Plate Specifications
 - h. ASTM A 304 - Bolt Specifications
 - i. ASTM A 325 - Fastener Specifications
 - j. ASTM A 536 - Cast Iron Specifications
 - 2. American Iron and Steel Institute
 - a. AISI A- 4142, Heat Treated Steel Specifications
 - 3. ANSI – American National Standards Institute
 - 4. AGMA – American Gear Manufacturer’s Association
 - 5. ASME – American Society of Mechanical Engineers
 - 6. AWS – American Welding Society, Current Standards
 - 7. AFBMA – Anti-Friction Bearing Manufacturers’ Association
 - 8. NEMA – National Electrical Manufacturer’s Association

1.2 DESCRIPTION OF WORK

- A. This section covers the general requirements for the design, fabrication and installation of three (3) new suction header type Secondary Clarifier mechanisms and components as specified herein and shown on the Drawings for use in removal of activated sludge.
- B. Work and Components included, but not limited to items listed below:
 - 1. Drive mechanism complete with a gearmotor reduction unit, micro-switch torque overload devices and shear pin.
 - 2. Center support pier
 - 3. Center pier anchor bolt template

4. Unitube suction sludge removal header, manifold, seals, clamp kit and supports.
 5. Center cage, truss arm and tie chord A-frames with clevis assemblies
 6. Access bridge including center platform, grating, hand-railing and toe plate.
 7. One (1) surface skimmer assembly which includes scum blade and hinged skimmer assembly.
 8. One (1) scum trough with flushing device
 9. FEDWA® energy dissipating inlet (EDI) baffle system and supports.
 10. Flocculation feedwell and supports.
 11. All associated hardware and anchor bolts
- C. The Secondary Clarifier mechanisms shall be so designed that there will be no bearings, chains, sprockets, or operating mechanism below water level. All gearing must be completely enclosed and oil lubricated.
- D. Contractor shall coordinate all work with this equipment and any other associated equipment, installed and specified under other sections of these specifications.

1.3 QUALITY ASSURANCE

- A. In addition to requirements of these specifications, comply with manufacturer's instructions and recommendations for work.
- B. Manufacturers regularly engaged in the manufacture of the Secondary Clarifier mechanisms as specified herein and who can demonstrate equipment of this specified design, in actual service for a period of not less than 15 years at ten (10) different plants will be considered as acceptable manufacturers.
- C. Manufacturers shall show evidence of quality assurance in manufacturing and supplying equipment essential in details to the equipment herein specified. This assurance will be met by certification to the quality system requirement or equivalent standard as accepted by the Engineer.

1.4 SYSTEM DESCRIPTION

- A. It is the Contractor's obligation to properly erect and install the Secondary Clarifier No. 1, 2 and 3, and all associated accessory items necessary for proper installation and operation of the equipment.
- B. The Secondary Clarifiers equipment shall be designed to effectively settle mixed liquor suspended solids received after the Oxidation Ditches and remove the settled solids from the basin floor to the sludge withdrawal manifold as shown on the Contract Drawings. The clarifier effluent shall be collected uniformly by the peripheral launder. Surface scum shall be collected by the full radius scum skimming arm and discharged through the scum discharge pipe.

C. Process Requirements:

	Units	Clarifier No. 1	Clarifier No. 2	Clarifier No. 3
Minimum Flow, each unit	MGD	0.28	0.28	0.44

Average Day Design Flow (ADDF)	MGD	0.56	0.56	0.9
Maximum Flow, each	MGD	1.4	1.4	2.2
Peak Hourly Flow (PHF)	MGD	1.97	1.97	2.7
Design Average Recycle Flow	-	100%	100%	100%
Mixed Liquor Suspended Solids	mg/L	3500	3500	3500
Solids Loading:	lbs/sf	31.13	31.13	27.32
Surface Overflow Rate				
@ ADDF, MGD	gpd/sf	237	237	234
@ PHF, MGD	gpd/sf	829	829	702

D. Clarifier Mechanism Design Equipment

	Clarifier No. 1 & 2	Clarifier No. 3
Internal Diameter, ft	55	70
Side Water Depth, ft	12	14
Floor Slope	1/12	1/16 per 12
Center Pier		
Minimum inside diameter, inches	18	20
Flocculation Well		
Diameter	12'-5"	14'-9"
Depth below water surface	4'-0"	5'-0"
Minimum number of Scum Ports		6
Well Thickness		3/16
Configuration		Circle
FEDWA / EDI Energy Dissipating Inlet		
Plate Thickness		
Impingement zones	3/16"	3/16
	4	4
Skimmer and Scum Trough		
No. of skimmer arms	1	1
Trough width	4'-0"	4'-0"
Ball Race Diameter	30	30
Torque Requirements		
AGMA Rated Torque, ft-lbs.	12100	12100
Motor Shut-Off Torque, ft-lbs.	14520	14520
Momentary Peak Torque, ft-lbs.	24200	24200
Service Factor	1.25	1.25
Drive Output Speed, RPM	0.04	0.04
Drive housing	Cast iron	Cast iron
Non-Submerged steel	A36 carbon steel	A36 carbon steel
Submerged steel	A36 carbon steel	A36 carbon steel
Grating	1 1/4-inch aluminum grating	1 1/4-inch aluminum grating
Handrails	Aluminum	Aluminum
Anchor bolts and hardware	Type 316 stainless steel	Type 316 stainless steel

1.5 SUBMITTALS

- A. The Contractor shall submit manufacturer's technical data and application instruction in accordance with the General and Supplementary Conditions and Division 1 Specifications and any additional information listed herein.

- B. Product Data: Submit Manufacturer's product specifications, performance data sheets, and installation instructions for each principal component of the Secondary Clarifier mechanism.
- C. Shop Drawings: Submit plans, elevations and details for work not fully shown by published product data; include rough-in dimensions and service connection details.
 - 1. Certified general arrangement drawings and tank dimensional drawings.
 - 2. All major tank and mechanism dimensions and elevations.
 - 3. Certificate of design stamped by a registered Professional Engineer stating that the equipment to be provided for this project meets or exceeds requirements of these specifications. The certificate shall state the respective loads and design criteria.
 - 4. Mechanism loadings on the tank
 - 5. Drive mechanism rating calculations, stamped by a registered Professional Engineer, verifying the compliance of the drive gears and bearings with the specified continuous torque rating and bearing life rating.
 - 6. Calculations shall be provided showing the drive components clearly meet the torque requirements.
 - 7. Motor data and catalog information. Electrical drawings as applicable to the supply of the Intermediate Clarifier mechanism manufacturer.
 - 8. Catalog cut sheets for purchased sub-components.
- D. Maintenance Manuals: Operation and maintenance manuals shall be provided by the Intermediate Clarifier mechanism manufacturer at least two (2) weeks prior to shipment of all major equipment components. Each manual shall be a bound, indexed binder with drawings and parts lists prepared specifically for this project rather than general instructions that are not designed for this project. At a minimum the manual shall contain:
 - 1. Certified as built drawings – Detailed arrangement.
 - 2. Certified as built drawings - General arrangement details.
 - 3. Erection drawings.
 - 4. A complete bill of materials for the equipment including the weights of all structural steel components.
 - 5. Installation and maintenance instructions for the specific equipment including the erection sequence, maintenance and trouble-shooting check points, and complete lubrication procedures with recommended grades of lubricants.
 - 6. Cut sheets for all equipment items purchased from sub-vendors.
 - 7. A list of the Secondary Clarifier mechanism manufacturer's recommended spare parts specifically denoting wear items, long delivery items, and all items convenient for stocking as optional replacement items.

1.6 DELIVERY

- A. Fabricated assemblies shall be shipped in the largest sections permitted by carrier regulations, properly match marked for ease of field erection.

- B. All components shall be erected immediately upon receipt from the Intermediate Clarifier mechanism manufacturer or stored in strict conformance with storage recommendations provided by the Secondary Clarifier mechanism manufacturer in the operations and maintenance manual.
- C. The Intermediate Clarifier mechanisms shall be lubricated in strict accordance with the instructions of the Secondary Clarifier mechanism manufacturer's field service representative. The required lubricants shall be provided by the Contractor.

1.7 WARRANTY

- A. A written supplier's warranty shall be provided for the equipment specified in this section. The warranty shall be for a minimum period of five (5) years from start-up or 66 months from time of equipment shipment, whichever comes first. Such warranty shall cover all defects or failures of materials or workmanship which occur as the result of normal operation and service except for normal wear parts (i.e., squeegees, skimmer wipers, etc.).

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. The Secondary Clarifier mechanisms shall be in compliance with these specifications and plans and shall be supplied by the following manufacturer:
 - 1. Evoqua Water Technologies, LLC-Envirex Products, of Waukesha, WI
 - 2. Walker Process
 - 3. Ovivo-Emco
 - 4. Or Engineer approved equal.

2.2 GENERAL

- A. The equipment shall be designed to effectively settle mixed liquor suspended solids after Oxidation Ditch and withdraw settled solids from the tank floor as shown on the Contract Drawings.
- B. The clarifiers' mechanism shall be of the center-drive type, center support pier, siphon feed, and peripheral overflow type with a central driving mechanism which shall support and rotate a center cage with two collector arms attached. The flow entering at the bottom of the influent column and flowing upward to the inlet openings located at liquid level. The clarifier shall perform the following integrated functions:
 - 1. Dissipate energy and control localized currents.
 - 2. Separate solids from the clear liquid.
 - 3. Evenly withdraw the clear liquid.
 - 4. Transport and thicken settled sludge.
 - 5. Remove scum from the clarifier surface.

2.3 MATERIALS

A. Structural Steel

1. All steel design shall be in accordance with the AISC Manual of Steel Construction, latest edition, and the International Building Code (IBC), latest edition.
2. All steel components shall be galvanized steel, ASTM A123/A123M latest edition.
3. Shall conform to the requirements of "Standard Specifications for Carbon Structural Steel," ASTM A-36, latest standard.
4. All steel plate shall conform to ASTM A283C requirements, latest standard.
5. All shop welding shall conform to the latest standards of the American Welding Society. Structural support members shall be shop welded for bolted field assembly.
6. Except where specifically indicated otherwise, all plates and structural members designated for submerged service shall have a minimum thickness of 1/4 in.
7. All stainless steel shall be Type 304 stainless steel.
8. Sharp corners of cut or sheared edges will be dulled with one pass of a power grinder to create a smooth edge.
9. Design components so that stresses developed do not exceed allowable stresses, as defined by current AISC standards when designed for the AGMA rated torque.

B. Grating

1. I-bar, 1-1/4 inch aluminum grating.

C. Handrail

1. Aluminum, double rail with toe plate, 1-1/2 inch diameter.

D. Anchor bolts and hardware:

1. All anchor bolts and hardware shall be a minimum of 1/2 inch diameter and made of Type 316 stainless steel. The equipment supplier shall furnish all anchor bolts, nuts, and washers, fasteners required for the equipment.

E. FRP shall be approximately 30% fiberglass, 70% polyester resin and have all surfaces smooth, resin rich, free of voids and porosity, without dry spots, crazes, or unreinforced areas. Minimum properties required for FRP are:

Tensile Strength	14,000 psi	ASTM D-638
Flexural Strength	25,000 psi	ASTM D-790
Flexural Modules	1 x 10 ⁶ psi	ASTM D-790
Barcol Hardness	40	ASTM D-2853
Water Absorption, % 24 hours	0.20	ASTM D-570

F. Fabrication

1. All welding to conform to American Welding Society Standard AWS D1.1 (AWS D1.2-Aluminum, AWS D1.6-Stainless Steel), of the American Welding Society. Structural support members shall be shop welded for bolted field assembly. All welded connections shall develop the full strength of the connected elements and all joined or lapped surfaces shall

be completely seal welded with a minimum 3/16" fillet weld. Intermittent welding shall not be allowed, except on non-ferrous metals. Field welding shall be limited to bridge splices and tack welding of skimmer connections after Secondary positioning.

- G. Design components so that stresses developed do not exceed allowable stresses, as defined by current AISC standards when designed for the AGMA rated torque.
- H. Panel lengths and member sizes shall be selected such that slenderness ratios do not exceed 200 for compression and 240 for tension. For strength, the controlling member force shall be used to determine member size.
- I. Maximum deflection in a span under combined live and dead loads shall not exceed $L/360$.
- J. Edge Grinding
 - 1. Sharp projections of cut or sheared edges of ferrous metals shall be ground to a radius by multiple passes of a power grinder as required to ensure satisfactory coating adhesion.

2.4 COMPONENTS

- A. Drive Mechanism
 - 1. The Drive Mechanism shall consist of an electric drive motor with a torque overload protection system, primary/secondary worm gear reducer, chain & sprockets with FRP or 16 ga. grade 304 stainless steel guard, shear pin coupling, intermediate worm gear reducer and pinion gear with enclosed spur gear in a heavy duty gray cast ASTM A48 Class 40B housing.
 - 2. Gear Design and Rating Criteria (minimum):
 - a. AGMA Rated Torque: 12,100 ft. lbs.
 - b. Motor Shut-Off Torque: 14,520 ft. lbs.
 - c. Momentary Peak Torque: 24,200 ft. lb.
 - d. Mechanism rotation: Clockwise
 - e. Drive Output Speed: 0.04 RPM
 - 3. The drive assembly shall be rated to operate at the continuous torque or Normal Running Torque (NRT). This torque is the maximum torque required for normal operation of the mechanism on a 24 hr/day, 365 days per year 20-year service basis at specified sludge collector arm speed.
 - 4. The drive AGMA torque rating shall be as specified above with a minimum 1.25 service factor.
 - 5. The drive design torque is the maximum torque that the mechanism can achieve before activating an overload alarm. Micro-switches shall be factory set to: (1) sound an alarm when the load on the mechanism reaches 100% of the AGMA torque; and (2) stop the motor when the load reaches 120% of the AGMA torque.
 - 6. Momentary Peak Torque is the dynamic load capacity of the drive assembly developed momentarily as starting torque or a sudden buildup of torque.
 - 7. All gears shall be designed for surface durability, strength & geometry in accordance with the latest applicable standards of the ANSI/AGMA, and British Standard of spur, worm, and helical gearing. All bearings shall be selected in accordance with applicable AFBMA-ANSI standards.

8. All bearing shall be anti-friction type running in oil and designed for a minimum B-10 life of 20,000 hours.
9. All cylindrical worm gearing shall conform to AGMA 6034-B92, Practice for Enclosed Cylindrical Wormgear Speed Reducers and Gearmotors.
10. The worm and worm gear shall operate in an oil bath. A sight gauge shall be provided for observation of the oil level.
11. All pinions and spur gears shall conform to AGMA 2001-D04, Fundamental Rating Factors and Calculation Methods for Involute Spur and Helical Gear Teeth.
12. The drive shall be designed to allow removal and replacement of internal gear, balls and strip liners without raising the walkway.
13. The complete center drive assembly, including the overload protection device, shall be a regularly manufactured product of the clarifier manufacturer. The center drive assembly is a key element in a successful clarifier installation; therefore, drive assemblies purchased from third party vendors will not be accepted.
14. The motor shall be totally enclosed, fan cooled, with a 1.15 service factor. Operating electric current will be 230/460 volt, 3 phase, and 60 hertz. Each motor shall be NEMA Design B employing Class F insulation designed for an ambient temperature of 104 °C.
15. The gear motor primary speed reducer shall drive a secondary worm gear reducer through a #80 self-lubricating roller chain and steel sprockets enclosed in FRP or 16-gauge stainless steel guard. Sprockets and chain shall be designed for the connected horsepower of the drive with a minimum service factor of 4.0. Provision shall be made for adjustment of chain tension.
16. Provide proper chain tension by an adjustable steel base mounted on the intermediate reduction unit.
17. The main spur gear material shall be high strength ductile iron per ASTM A536 grade 80-55-06 or equal.
18. The main gear shall rotate and be supported on a ball bearing assembly provided with four replaceable liner strips fitted into the main gear and turntable base. Liner strips shall be special vacuum degassed carbon corrected alloy steel hardened to a Rockwell hardness of at least 39 to 43 RC. The turntable base shall be a minimum 1-inch thick to insure adequate structural rigidity to properly support the drive bearing and gear.
19. The main gear and bearing shall be completely enclosed in an ASTM A-48 Class 40B cast iron housing provided with neoprene dust seals. In order to ensure the maximum possible base rigidity and vibration dampening, the gear housing shall be of full sidewall construction, integral with the base. Prior to assembly, the base shall be thoroughly inspected for seep holes or inclusions and given a hydrostatic test to insure no leaks are in the oil containment area. If requested, shop inspection reports shall be made available for review.

B. Drive Overload Control

1. Option 1:
 - a. The drive unit shall be equipped with an electro-mechanical torque overload control device actuated by thrust from the worm shaft. The pointer shall provide a visual reading of the relative main gear output torque on a 0 to 100 percent graduated scale. The 100 percent reading shall equal the 100 percent drive rating as specified

above. The control device shall also activate an alarm switch for warning of impending torque overload, a motor cutout switch for overload protection and a back-up safety motor cutout switch for back up overload protection.

2. Option 2:
 - a. Protect the drive by two separate and independent overload systems. The system shall consist of a shear pin. Base the setting of these devices on the normal running torque (NRT). Base the alarm settings on the NRT of the equipment as supplied, if greater than that specified.
 - b. Equip the electro-mechanical system with two adjustable limit switches built into the drive mechanism. Set one limit switch to energize an alarm when the torque load reaches 100% of the NRT. Set the second switch, to de-energize the drive motor and energize an alarm when the torque load reaches 120% of the NRT. Provide a visual torque load indicator strategically located to clearly show the percentage of the NRT load at which the unit is operating.
 - c. Design the shear pin to shear at 140% of the NRT. Provide a limit switch to de-energize the drive motor and energize an alarm when the pin has sheared or provide a third limit switch in to serve as a back-up motor cutout. Shear pin limit switch shall be manual reset type.
 - d. All three limit switches shall be furnished, installed, and set under this Item. Limit switches shall be rated NEMA 4X and have 15-amp CPDT contacts.

C. Drive Assembly

D. The drive assembly shall consist of a right angle gearmotor or parallel shaft gear-motor with totally enclosed motor for operation on 3 phase, 60 hertz, 460 volt current, and a roller chain drive with an enclosed weatherproof guard fabricated of sheet steel.

E. The gearmotor shall have a motor of a minimum 1/2 HP or per manufacturer based on diameter, and the gear unit shall have a minimum service factor of 1.15 applied to the motor nameplate HP.

F. FEEDWA Flocculation Baffles

1. Provide inlet baffles to promote effective mixing and tapered flocculation.
2. Flow shall impinge three (3) overlapping vertical target baffles in secession with a series of four (4) impingement zones.
3. Design to provide a "Gt" (t in seconds) value in the well not exceeding 6,000 with a velocity gradient "G" within the well of at least 35 fps/ft and not exceeding 60 fps/ft at a minimum water temperature of 10 degrees-C at peak influent flow.
4. Provide horizontal shelf baffles to prevent downward movement in flocculation zone.
5. Baffles shall bolt to center cage and well support beams.
6. The baffles to be fabricated from minimum 3/16-inch thick A36 carbon steel plate.
7. Hydraulic calculations shall be provided showing dimensional characteristics, port area, velocity, headloss, and mixing intensity.
8. LA EDI system shall be the only acceptable alternative to the FEDWA design.

G. Flocculation Feedwell

1. The clarifiers shall be equipped with an energy dispersion well located inside the rotating flocculation feedwell. The dispersion well shall be designed to dissipate the energy of the incoming flow by way of multiple baffled inlet ports equally spaced around the dispersion well.
2. The flocculation well shall be construct of 3/16-inch steel plate sections supported from the drive cage or bridge extensions. The ports shall be equally spaced around the periphery.
3. Incorporate steel stiffeners at the top and bottom to maintain shape and rigidity.
4. Feedwell shall be of adequate size to diffuse the flow into the tank at a uniform flow through velocity.
5. Ports shall be cut into the flocculation feedwell to permit entrapped scum to escape.
6. Ports shall be baffled to prevent short circuiting to the weirs.
7. For the diameter of the proposed flocculation feedwell, straight segmented pieces are not allowed.

H. Center Peir

1. A cylindrical 1/4" thick steel plate center pier shall support the drive, collector mechanism and access bridge.
2. Top of pier to have a drive mounting plate set plumb with the centerline.
3. Drive to be positioned, leveled, and grouted in place on top of pier with a non-shrink grout.
4. Manufacturer to provide minimum eight (8) 1" diameter anchor bolts and steel template/grout shield to accurately locate anchors.
5. Center pier shall serve as the influent pipe.
6. Center pier shall have a minimum of four (4) overflow areas at its upper end to diffuse flow into the flocculation feedwell at a velocity not to exceed 1.75 fps at maximum design mixed liquor flow.

I. Sludge Collection Header

1. The header shall be parallel to the tank floor and have a series of inlet orifices such that the entire tank bottom is swept clean in a single revolution.
2. The header shall be designed to uniformly remove sludge in proportion to the area swept with the removal of a larger volume of sludge at greater distances from the tank center.
3. Sludge shall be transported through the header to the center manifold, with removal being accomplished by hydrostatic pressure.
4. Provide a fully tapered, rectangular-shaped Unitube header varying in cross section from a maximum near the tank center to a minimum at the outer wall.
5. Fabricate header from 1/4" thick steel plate.
6. Provide steel plate counterweights not exceeding 50# each as necessary for proper equipment balance. Field welding of galvanized header or supports will not be allowed.
7. Longitudinal cross-sectional axis to be mounted at an angle of 45 degrees to tank bottom to trap sludge.
8. Provide a 2" fluidizing vane as an integral part of header. Attach neoprene squeegee to fluidizing vane provided with 1" vertical adjustment.

9. Manufacturer to size and space header inlet orifices at regular intervals not exceeding 30".
10. Orifice design to be proportionate to the volume of sludge withdrawn from the entire tank floor at all flows.
11. Provide header flange with silicone seal for bolted connection to center manifold. Tie bar shall provide header support.
12. Alternate Manufacturers shall submit header verification field data in accordance with the Substitute Equipment Section of this specification.
13. Sludge withdrawal by means of individual riser pipes or stepped header construction will not be acceptable.

J. Center Cage, Truss Arm and Manifold

1. Center cage to be of an all-welded box truss construction made up of structural steel members having a minimum thickness of 1/4"
2. Truss arm shall be furnished with a triangular three-point contact design for ease of installation and alignment. Truss shall be constructed with 1/4" minimum thick members. Truss shall be pinned at the base for vertical adjustment and connected to the center cage through strut and adjustable clevis assembly. Tie-rod and turnbuckle designs that do not provide lateral support will not be acceptable.
3. Provide a cylindrical manifold with two (2) seals for bolted connection to the sludge collection header and bottom of cage. A bottom seal plate shall be furnished by the equipment Manufacturer securely anchored to the floor and grouted in place after secondary adjustment.

K. Surface Skimmer

1. Provide One (1) skimmer assembly consisting of scum blade and hinged wiper assembly.
 - a. The scum blade shall span the full length between the flocculation feedwell and scum trough. Scum blade shall have a height of 5-in rigidly attached to vertical pipe supports and structural A-frame. The A-frame shall be bolted to the truss arm at maximum of 15' spacing.
 - b. Mount a hinged wiper assembly on the end of the scum blade to form a pocket for trapping scum. The wiper assembly shall maintain continual contact and proper alignment between scum blade, outer scum baffle and scum trough. The wiper blade shall have a wearing strip on its outer end which contacts the scum baffle and neoprene strip on its inner and lower edges which contact the scum trough.
 - c. All springs, pivot points and threaded fasteners shall be constructed of 304 stainless steel. The hinged wiper assembly shall be hot dipped galvanized. The wiper blade shall be neoprene with Durometer range 50-60. The wiper assembly shall be the same dimension of the scum trough.
 - d. Provide a manual lockout mechanism on hinged skimmer assembly to allow for flexible independent operation for surface ice. Lockout mechanism shall raise hinged skimmer assembly above water surface without removal.
2. Provide one (1) scum trough 4'-0" wide with inclined beach of 1/4" thick plate, supported from the tank wall.
 - a. Scum trough shall have an overall length of 4'-9" along the scum baffle consisting of beach plate, inner radius baffle, hopper and 6" discharge pipe. Manufacturer shall provide a loose plate flange for contractor to field weld and connect to scum drain piping.

- b. Beach plate to slope at a nominal incline of 1-3/4" per foot to a point 5" below the maximum water elevation. The trough shall be provided with a submerged shelf extension spanning an additional 4'-0" along the scum baffle. An inner radius baffle extending 9" below and 3" above maximum water level shall run from the trough to the end of the submerged shelf.
 - 3. Provide a counterweighted flushing device actuated by the main tank skimmer arm. Actuator arm shall pivot on a 3/4" minimum diameter stainless steel pin riding in an oil impregnated sintered bronze bushing. The actuator arm shall be counterweighted by steel plates to assure positive valve closure. The flapper valve shall be held open to allow 15 to 20 gallons of flushing water per trip.
- L. Walkways Access Bridge
 - 1. Provide a bridge of wide flange beam or pony truss construction extending from the tank wall to the stationary drive base.
 - 2. Provide a bridge extension to provide access to the far-side of the drive mechanism.
 - 3. Bridge to be designed for the dead load and a live load of 50 pounds per square foot. Deflection shall not exceed L/360 when both the dead load and live loads are applied. It shall consist of two trusses or beams with 1-1/4 inch aluminum I-bar grating between the trusses or beams.
 - 4. Provide a 3' wide walkway of 1-1/4" x 3/16" 1 1/4-inch aluminum grating extending over the entire bridge length.
 - 5. The walkway shall be diagonally braced against lateral movement, and provided with handrails 42 inches high, of double-row 1-1/2 inch diameter horizontal aluminum pipe for rails, Schedule 80 posts. Post spacing not to exceed 5 ft. Provide a 4" high aluminum toe plate along both sides of bridge and bridge extension. Walkway trusses may serve as the handrail if the top chord is 3 feet-6 inches above the walking surface.
 - 6. Provide a minimum 8'-0" x 10'-0", rectangular platform to provide a 2' working clearance around the drive.
- M. Provide aluminum handrails with toe plate around the center drive platform. The handrailing shall be in conformance with the handrail specifications, found within this set of bid documents, and shall be as shown on the drawings.

2.5 WEIR PLATES AND SCUM BAFFLE

- A. Weir plates and baffles shall consist of the following:
 - 1. Effluent FRP "weir plates: 10-inch high x 1/4-inch thick section with 2-1/2 inch deep 90 degree V-notches at 6-inch weirs on one side of the troughs
 - 2. Scum Baffle: The baffle shall consist of 1/4-inch thick x 12 inches deep fiberglass sections, on one side of the troughs. In the area of the scum box the scum baffle shall extend to 24 inches starting approximately 6 feet before and ending 2 feet after the scum box. The baffle sections shall be curved and fastened to the launder wall with adjustable FRP support brackets, stainless steel fasteners, and anchor bolts.
- B. Resin - The resin shall be a commercial grade isophthalic polyester thermosetting resin, Corezyn COR75-AQ-010 or equivalent, which has either been evaluated in a laminate, or which has been

determined to be acceptable for use in a waste treatment plant environment. The resin shall contain no fillers. The standard color for the trough shall be green. Ultraviolet stabilizers are required in all trough laminates.

C. Reinforcements:

1. Metal reinforcement shall be free of rust, oil, and any foreign matter. They shall be completely encapsulated with a minimum of 1/8" thick laminate.
2. Glass mat reinforcement shall consist of chemically bonded surfacing mat and chopped strand or chopped strand mat as hereinafter described. Surfacing mat shall be 0.020 inches thick reinforced with a surfacing mat of Type C veil, 10 to 20 mils thick, with a silane finish and a styrene-soluble binder compatible with the resin; the glass content of this layer shall not exceed 20% by weight. Chopped strands shall be Type E glass, with silane finish and styrene-soluble binder.
3. Woven Roving Reinforcement - The finished laminate shall include one layer of 24 ounce woven roving reinforcement over the entire trough surface.
4. Additional reinforcement in the form of foam or balsa sheet for high stress areas at the sides and bottom of the trough shall be completely encapsulated within the laminate. Care shall be taken to insure that these areas of the trough laminate are not designated as attachment points or drilled for any purpose.

D. Laminate Construction

1. Inner trough surface shall be a resin rich layer 0.020 inches thick reinforced with a 10-20 mil 'C' veil surfacing mat. This resin rich layer shall contain less than 20% by weight of the reinforcement veil. A gelcoat interior surface may be provided.
2. Structural layers shall consist of plies of chopped strand mat with a maximum of 2 ounces per square foot per spray-up pass. Inter-layered between two layers of mat shall be one layer of 24-ounce woven roving over the entire trough structure. Each successive pass of reinforcement shall be thoroughly wetted with resin and shall be well rolled to exclude all air pockets and bubbles prior to the application of additional reinforcement.
3. Outer trough surface shall consist of a resin rich layer not less than 0.020 inches thick. The outer layer resin shall be applied after cure of the structural layer and suitably embed all reinforcing fibers.
4. Finished trough shall be a minimum of 30% fiber reinforced with a minimum thickness of not less than 1/4". The laminate tolerance thickness shall be +10%.
5. Materials used in the manufacture of the FRP troughs shall be new stock of the best quality and shall be free from all defects and imperfections that might affect the performance of the finished product.

E. Guarantee

1. The equipment manufacturer shall guarantee each unit being supplied to the Owner against defects in workmanship and material for a period of two (2) years under normal use, operation, and service.
2. In the event a component fails to perform as specified or is proven defective in service during the guarantee period, the manufacturer shall provide a replacement part without cost to the Owner. The contractor shall provide, without cost, such labor as may be required

to replace, repair, or modify all materials and equipment provided pursuant to this specification.

F. Manufacturer:

1. NEFCO Inc.
2. FFI, Fiberglass Fabricators, Inc.
3. MFG Construction & Water Products.
4. Warminster Fiberglass Company
5. Edgeng Engineering Inc.
6. Or approved equal.

2.6 STAMFORD DENSITY CURRENT BAFFLE

A. The Stamford Density Current Baffle is an advanced baffle designed to improve the performance of the clarifier by intercepting the density currents formed within the clarifier and redirecting them back into the main clarification volume of the tank. FRP current density baffles shall be installed around the tank wall as shown on the contract drawings.

B. The Stamford Density Current Baffle shall consist of a series of baffle panels that are attached to the wall of the clarifier to form an inclined, shelf-like surface around the entire inner periphery of the tank. Each panel shall be molded of corrosion-resistant, UV-treated fiberglass. The panel shall be a maximum of 10 feet in length and shall be curved to follow the curvature of the clarifier tank. The inclination angle of the baffle shall be 30 degrees as measured from the horizontal and the horizontal projection of the baffle shall be defined by the following equation:

$$\text{Horizontal Projection (inches)} = 18 \text{ inches} + 0.3 \text{ in/ft.} \times (\text{tank diameter (ft.)} - 30)$$

C. The top of the panels shall not be sealed against the tank wall to prevent buildup of floating solids and gas accumulation.

D. Construction of the baffles shall consist of 4 feet square 1/4-inch plate FRP panels attached to FRP supports with the use of 304 stainless steel self-taping Tek screws.

E. Provision shall be made to attach the panels to the clarifier wall and support them at the proper angle using a triangular panel bracket or two (2) protruded triangular brackets. Panels may be cut as required to fit around obstructions.

F. In tanks with inboard launders, the baffle shall be designed to fasten to the trough face at the lower inboard corner of the trough. In this case the baffle bracket will extend beneath the trough and fasten to the underside of the trough. The length of the density current baffle attached to the launder shall not be less than 24 inches.

G. A method of interconnecting adjacent panels shall be provided such that the entire assembly forms a rigid structure capable of supporting its own weight plus snow and wind loads in the event the tank is out of service. The baffle shall also be designed to withstand a buoyant force load equal to the weight of the water displaced from the volume beneath the baffle. The angled working surface of each baffle shall be sufficient in pitch and width to divert the flow and to create

a self-cleaning action of the baffle itself. Provision shall also be made to vent gases which may form beneath the baffle through the openings in the panel at its highest point.

H. Materials

1. FRP shall be approximately 30% fiberglass, 70% polyester resin. Each baffle panel shall be molded of fiberglass reinforced plastic. The resins and fiberglass reinforcing material shall be consistent with the environmental conditions and structural requirement and have all surfaces smooth, resin rich, free of voids and porosity, without dry spots, crazes, or unreinforced areas. The resin shall be an isophthalic polyester resin suitable for use in submerged waste treatment applications. The resin shall be treated to provide UV suppression. Each panel shall have the following minimum physical properties:

Property	Minimum Value	Test
Tensile Strength	10,000 psi	ASTM D-638
Flexural Strength	16,000 psi	ASTM D-790
Flexural Modulus	1,000,000 psi	ASTM D-790
Barcol Hardness	40	ASTM D-2853
Notched Izod	12 ft-lbs/in	ASTM D-256
Water Absorption	0.2% (max.)	ASTM D-570

2. Glass reinforcement shall consist of chemically bonded surfacing mat and chopped strand roving. The glass content of the finished laminate shall not be less than 30% by weight. The nominal thickness of each baffle panel shall be 1/4 inch + 1/16 inch thick with resin rich surfaces and edges to prevent migration of moisture and fiber "blooming."
3. All factory-trimmed edges shall be "hot coated" with resin to prevent wicking.
4. The installation contractor shall field verify existing dimensions and install the baffle in accordance with the contract drawings, approved shop drawings and manufacturer's recommendations. Mounting holes shall be factory drilled. Field cutting of baffle panels will be allowed to complete the structure and accommodate in-tank obstructions. All field cut or drilled edges shall be coated per the manufacturer's recommendations to prevent fiber blooming or fraying. All of the fasteners required for installation shall be supplied by the baffle manufacturer. The baffle panels shall be attached to the wall using 3/8" x 3-3/4" concrete expansion anchors with oversized 1/8" x 2-1/4" stainless steel fender washers, and hex nuts. Adjacent baffle panels are fastened together using 3/8" bolts, 2 flat washers, lock washer, and hex nut. All the installation fasteners shall be stainless steel.
5. The density current baffle shall extend completely around the tank and shall be level, rigid and free of sway that could work anchors loose or cause undue wear.

I. Manufacturer:

1. NEFCO
2. FFI
3. MFG
4. Warminster Fiberglass Company

5. Edgeng Engineering Inc.
6. Or approved equal.

2.7 ELECTRICAL

- A. The Contractor shall furnish all labor, equipment, and materials to install a control center for each motor in a NEMA 4X enclosure, pedestal mounted, for operation on a 480 volt, 3 phase, 60 Hertz, 3 wire service.
- B. Motors
 1. Motors shall be polyphase electric, and be wound for 460 volts, 3 phase, 60 Hertz. Furnish each motor in accordance with NEMA and IEEE standards, suitable for severe duty applications with all the following requirements:
 - a. Totally enclosed with epoxy enamel finish coat.
 - b. All cast iron structural parts.
 - c. Epoxy coated air gap surfaces of rotor and stator.
 - d. Non hygroscopic Class F insulation.
 - e. 1.15 service factor.
 2. All continuous rated polyphase electric motors shall be of the "energy efficient type". Efficiency and losses shall be determined in accordance with the latest IEEE Standard 112 and NEMA Motor Generator Standards MG1 12.53a and MG1 12.53b.
- C. For new Secondary Clarifier No. 3 motor, the equipment manufacturer shall include: a combination circuit breaker/overload unit providing overload protection, short circuit protection, manual reset disconnection for all phases; across-the-line magnetic contactor; control circuit transformer with primary overload protection. If a motor is disabled (e.g. overload, overtemp, individual disconnect in "Off" position), it shall shut down and lockout.
 1. For existing Secondary Clarifiers No. 1 and 2 replace each motor in kind.
- D. Units shall be pre-calibrated to match motor and control characteristics and factory sealed to insure trip setting is tamper-proof; hand/off/automatic operation selector switch; selector switch for remote or local control; provide all necessary auxiliary isolated contacts for computer interface; running pilot light on operator's control plate; running time meter mounted on operator's control plate, a minimum 2 watt strip heater to provide condensation protection, lightning arrestor, and weatherproof alarm light with guard.
- E. The equipment supplier shall furnish all electrical items specifically called for in this specification section. The contractor shall supply and install all other electrical items required to place the equipment into service.
- F. The contractor shall supply and install all field wiring required including but not limited to proper size wire, conduit, fittings, and supports.

2.8 SURFACE PREPARATION AND PAINTING

- A. All steel components shall be Hot-Dipped Galvanized (HDG) after fabrication per ASTM-A123. Galvanized and stainless-steel components shall be unpainted.

- B. The center drive mechanism shall be shipped, assembled and finish painted with manufacturer's standard paint system.
- C. Shop Painting
 - 1. Prior to assembly of the drive unit, the castings shall have been sandblasted and thoroughly cleaned to remove any foreign particles in the drive base. After assembly, the drive mechanism shall be solvent cleaned and power wire brushed as needed prior to application of manufacturer's standard primer.
 - 2. Protect all exposed ferrous metals with a minimum of one coat of Tnemec N140F shop primer for a minimum of 4-5 mils DFT. Apply an additional coat of machinery enamel to motors, pumps, gear boxes, and other similar equipment.
- D. Field Finishing
 - 1. All iron and steel surfaces, except the drive unit, shall be field cleaned and painted by the Contractor to ensure paint compatibility and assign unit responsibility for the coating system. The drive unit shall be coated with the supplier's standard enamel paint system.
 - 2. Complete field finishing of all materials under Division 09801 as required excluding galvanized, aluminum, bronze, plastic or other items which do not require field finishing.
 - 3. Prior to applying finish coating, shop-primed items shall be cleaned as per SSPC-SP1 Solvent Cleaning. Sand and scrape to remove loose primer and rust and primer bare steel surfaces.
 - 4. Primers: Tnemec 37-77 Chem-Prime, Kop-coat 340 Gold Primer, or equal.
 - 5. Compatibility: Contractor responsible for compatibility of shop coatings with field finishes. Contractor to provide written specifications on field finishes to equipment manufacturer.
 - 6. Gear motors shall be furnished with manufacturer's standard enamel.

2.9 SPARE PARTS

- A. Manufacture to supply following spare parts:
 - 1. One (1) set of neoprene seals for suction header, sludge collection manifold, and scum skimmer arm.
 - 2. One (1) set of all drive gaskets.
 - 3. One (1) set of bearings except main bearing.
 - 4. Two (2) oil sight glass (upper and lower housing)
- B. These parts shall be identified, prepared, and packed for long-term storage.

PART 3 - EXECUTION

3.1 ERECTION

- A. The equipment shall be installed properly to provide a complete working system. Installation shall follow the supplier's recommendations.

- B. Prior to or with the delivery of equipment, the manufacturer shall provide copies of an operation and maintenance manual including storage, installation, start-up, operating and maintenance instructions, and a complete parts list and recommended spare parts list. The O & M manuals shall be in compliance with the General Requirements.

3.2 INSTALLATION

- A. Install clarifier system and accessories in accordance with the manufacturer's instructions.
- B. All lubrication required for initial operation shall be furnished and applied in accordance with the manufacturer's recommendations.
- C. Furnish any service items required for initial operation. Prepping equipment shall be in accordance with the manufacturer's recommendations.
- D. Install all associated items including piping and operating items.
- E. Install concrete floor topping with the scraper mechanism as recommended by the manufacturer.
- F. Prior to the center column being grouted in place, the drive unit shall be installed, positioned, and leveled.
- G. A 2" layer of grout shall be applied to the tank floor by the contractor in accordance with the manufacturer's recommendations. Scream boards shall be supplied by the erecting contractor.
- H. After the manufacturer has approved the installation, and prior to startup, the Contractor shall clean all surfaces in accordance with the manufacturer's instructions.

3.3 ELECTRICAL

- A. Unless noted otherwise all motor starters, selector switches, indicating lights, and all other devices to form a complete operating electrical system shall be supplied, mounted and wired in Division 26 - Electrical.
- B. All electrical equipment, conduit and wiring not indicated on the Drawings, but necessary to provide a complete operating system shall be provided at no additional cost to the Owner.
- C. Electrical Wiring: The external conduit and wiring required for power supply and control to electrical equipment supplied in this Section will be furnished and installed in Division - 26, Electrical.

3.4 INITIAL LUBRICATION

- A. All lubrication required for initial operation shall be furnished and applied in accordance with the manufacturer's recommendations.
- B. Prior to or with the delivery of equipment, the manufacturer shall provide copies of an operation and maintenance manual including storage, installation, start-up, operating and maintenance

instructions, and a complete parts list and recommended spare parts list. The O & M manuals shall be in compliance with the General Requirements.

3.5 INSPECTION, STARTUP, AND TESTING

- A. The equipment manufacturer shall provide a service representative properly trained in inspection and operation of the mechanism to approve the installation, certify that the torque settings of the drive overload protection device are correct, perform the torque test and instruct the owner's personnel on maintenance and operation. If additional service is required due to the mechanisms not being fully operational, at the time of service requested by the contractor, the additional service days will be at the contractor's expense.
- B. Torque Test:
 - 1. The clarifier mechanism shall be field torque tested. The purpose of the torque test is to verify the structural integrity of the mechanism structural steel design and center drive unit. The testing shall be carried out under the supervision of the equipment manufacturer's representative and as approved by the Engineer before the mechanisms are accepted and placed into operation.
 - 2. The torque test shall consist of securing the rake arm by cables to anchor bolts installed by the contractor in the tank floor at locations specified by the equipment manufacturer. A load shall be applied gradually to the scraper arm by means of a ratchet lever and cylinder connected to the cable assembly.
 - 3. The magnitude of the applied load shall be measured by calculating the torque from the distance of the line of action of each cable to the center line of the mechanism. A reading shall be taken at the 100% value of the drive design torque.
- C. The manufacturer's service representative shall verify that the alarm, motor cut-out, and backup safety motor cut-out switches are properly set and are in proper operation to protect the clarifier mechanism as specified.
- D. The representative shall also instruct the Owner's personnel in the operation and maintenance of the equipment.
- E. The manufacturer shall provide services by a factor-trained Service Representative, specifically trained on this type of the equipment for minimum four (4) workdays to perform above services. Whether or not these days are consecutive shall be dependent on the construction schedule.

3.6 INSPECTION AND CERTIFICATION

- A. A representative of the mechanism manufacturer shall inspect the tank mechanisms prior to their use for surfacing operations and certify that such equipment is ready for use in the procedure. The finished surfaces shall be inspected by the equipment manufacturer's representative and approved as being in accordance with the requirements of the equipment. Corrective measures, if required, shall be performed by the Contractor.

3.7 OPERATION AND MAINTENANCE MANUALS

- A. Prior to or with the delivery of equipment, the manufacturer shall provide copies of an operation and maintenance manual including storage, installation, start-up, operating and maintenance

instructions, and a complete parts list and recommended spare parts list. The O & M Manuals shall be in compliance with the General Requirements.

END OF SECTION 464324

SECTION 465361 - OXIDATION DITCH EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specifications sections, apply to work of this section.
- B. References
 - 1. AGMA – American Gear Manufacturers Associates
 - 2. AISC – American Institute of Steel Construction
 - 3. ASCE – American Society of Civil Engineers
 - 4. ASTM - American Society for Testing Materials
 - 5. ANSI - American National Standards Institute
 - 6. AWS – American Welding Society
 - 7. AWWA - American Water Works Association
 - 8. FM - Factory Mutual
 - 9. IEEE - Institute of Electrical and Electronic Engineers
 - 10. JIC - Joint Industry Conference
 - 11. NEC - National Electric Code
 - 12. NEMA - National Electrical Manufacturers Association
 - 13. OSHA - Occupational Safety and Health Administration
 - 14. SSPC – Steel Structures Painting Council
 - 15. UL - Underwriters' Laboratories Incorporated

1.2 DESCRIPTION OF WORK

- A. This section includes the furnishing, installation and repurposing of the existing equipment including:
 - 1. Aeration assemblies with hardware, including blades and torque tubes.
 - 2. Shaft assemblies including torque tubes, stab shafts, drive shaft and tail shaft, total of 3.
 - 3. Shaft-mounted drive assemblies replace drives, total of 6, 30 HP each.
 - 4. Bearings with bearing base plates
 - 5. Weatherhood access panels (existing re-used)
 - 6. Stainless steel anchor bolts
 - 7. DO probes and support assemblies, 1 for each train.
 - 8. Mixer with guide rail and crane assembly, 1 unit for each train.
 - 9. Integration with WWTP SCADA System
- B. This specification covers the general requirements for the design, fabrication and installation of one (1) Oxidation Ditch equipment as complete operational system, including electrical and instrumentation components required for satisfactory operation.
- C. Oxidation Ditch replacement equipment specified herein shall be the end products of only the **Lakeside Equipment Corporation**.
- D. The manufacturer shall provide test data proving that the aeration equipment will perform in accordance with the specifications when operated at the specified design conditions.

- E. All work performed under this section shall be in accordance with all approved trade practices and manufacturer's recommendations.
- F. Coordinate all work with this equipment and any other associated equipment installed under other sections of these specifications.

1.3 SYSTEM DESCRIPTION

- A. The existing Oxidation Ditch tanks at the City of Sunbury WWTP built in 2004 and designed based on the Closed Loop Reactor, as manufactured by the Lakeside Equipment Corporation.
- B. Raw wastewater after initial treatment on the mechanical screen (1/4" opening) and grit removal system is to be introduced into one of the Oxidation Ditch Splitter Box where, during normal operating condition mixes with the Return Activated Sludge (RAS) and overflows the controlled wear gate to the one of the Oxidation Ditch aeration channels.
- C. The existing Oxidation Ditch No. 1 and 2 structure consists of two (2) endless aeration channels arranged with common intermediate wall and a submerged port installed in an adjacent wall. The aeration channels are designed to operate in Series. The series operational mode allows for biological phosphorus removal and total nitrogen reduction.
- D. In series operation, the raw wastewater combines with the Return Activate Sludge (RAS) in the Splitter Box and enters either one of the aeration channels, and then it passes through the port to the second aeration channel. Effluent from the system is discharged out over the effluent weir. The first reactor is maintained in an anoxic state, with Dissolved Oxygen (DO) less than 0.5 mg/L and the second reactor is maintained in an aerobic state with a DO of 0.5-2.5 mg/L.
- E. The raw wastewater and RAS may be introduced into any one of the aeration channels, depending upon the operating conditions:
 - 1. Normal Operating Conditions at WWTP flow below 4 MGD:
 - a. Recycled activated sludge (RAS) during normal flow condition flows to the Oxidation Ditch Splitter box, where it combines with the influent flow from the primaries and continuous to the Oxidation Ditch No. 1 or 2.
 - b. Raw wastewater, after entering the system, shall pass progressively through the aerated channels of Oxidation Ditch No. 1 and 2 and then flow to the Secondary Settling Tanks (aka Final Clarifiers).
 - 2. Peak Flow Rate or Wet Weather Operation, at WWTP flow above 4 MGD:
 - a. During the time of peak flow rate or wet weather operation, the treatment flow pattern is converted to a "contact stabilization" mode of operation. The influent flow from the Splitter Box is diverted to the one of aeration channels. All the RAS flow is diverted to the other aeration channel and is stabilized.
 - b. RAS then flows to the first aeration channel where it mixes with the influent wastewater where "contact" occurs. The RAS flow continues at the same flow rate as it is pumped from the RAS Pump Station. The flow from one aeration channel to another shall be by displacement of the mixed liquor circulating in each channel through submerged port interconnecting adjacent aeration channel. The displaced flow shall be equal to the volume of raw waste and recycled sludge introduced into the aeration system.
- F. Oxygen requirement to be controlled by disc immersion and rotational speed.

1.4 SYSTEM PERFORMANCE

A. Design Flow Rates

Average Design Flow: 2.0 MGD
Maximum Day Flow: 5.0 MGD
Peak Hourly Flow: 6.0 MGD

B. Influent Characteristics of Wastewater

CBOD₅ = 160 mg/L
TSS = 170 mg/L
TKN = 36.1 mg/l
NH₃ = 30 mg/L
TP = 9 mg/L
pH = 6.5-7.5

C. Project NPDES Permit Limits for total WWTP effluent flow of 2.0 MGD.

	Final Effluent Limits	
	week, mg/L	month, mg/L
N-NH ₃ - Summer	1.5	1.0
N-NH ₃ - Winter	4.1	2.7
NO ₃ -N	10	
Total P	0.5	
CBOD ₅	15	10
pH	6.5-9.0	

1.5 QUALITY ASSURANCE

- A. All materials and equipment incorporated in the work shall be new and of the best quality.
- B. The equipment manufacturer shall have not less than ten (10) successful years' experience in the design, construction, and operation of the equipment specified at ten (10) different plants in state of Ohio.
- C. The Aeration/Mixing Equipment shall be provided by one manufacturer/supplier experienced in the design and production of similar type, size, and capacity equipment.
- D. The Engineer may require evidence, in the form of operating records, from these installations.
- E. In addition to requirements of these specifications, comply with manufacturer's instructions and recommendations for work.

1.6 SUBMITTALS

- A. Product Data: Provide unit capacities, projected effluent values, loading parameters, design parameters, oxygen requirements, dimensions, etc.
- B. Shop Drawings: The Contractor shall furnish detailed specific information with regard to the equipment and appurtenances proposed within 60 days of Contract Award. The Contractor shall furnish a complete set of detailed specifications and shop drawings including:

1. Size, type, construction and metallurgy of proposed equipment.
2. General arrangement and key plan for Oxidation Ditch.
3. General and detail arrangement sections and details for Oxidation Ditch.
4. Shaft mounted aerator drive assembly details.
5. General arrangement section and details of fiberglass weather hoods in aeration basin including clearance dimensions at the ends of each assembly and for opening the hoods.
6. Aerator layout including foundation support details.

C. Operation Data: Include description of system operation, adjusting and testing required.

D. Maintenance Data: Identify system maintenance requirements, servicing cycles, lubrication types required, and local spare part sources.

1.7 WARRANTY

A. The equipment manufacturer shall warrant all parts free from defective material and workmanship for one year from installation and furnish to the owner any such items found to be defective within the one (1) year period.

B. Correct defective work within a one-year period after substantial completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS (NOT USED)

2.2 EQUIPMENT

A. Renovation of the existing Oxidation Ditch will include:

1. Modify the existing Oxidation Ditch tanks to run both tanks in series flow with a single feed point for a raw wastewater and return sludge.
2. Re-use shafts and blades.
3. Provide Dissolved Oxygen (DO) probe in each aeration channel.
4. Replace drives and bearings.
5. Provide new Control System
6. The effluent from the final aeration channel shall be controlled by means of a submerged adjustable orifice gate and existing overflow weir, designed to allow a maximum liquid level variation of 10 inches in the aeration channels with variations in the flow of wastewater and recycled sludge.

B. Design Criteria

1. The existing rotary aerator assemblies shall be capable of delivering a maximum SOR of 282 lbO₂/hr per ditch. The oxygen values are measured at Standard Operating Requirements of 68°F (20°C) and 30" Hg.

C. Aeration Equipment (existing equipment)

1. The aeration equipment of the Oxidation Ditch system shall be as described herein and as shown on the Drawings.

2. The existing aeration equipment consists of six (6) complete rotary aerator assemblies designed for operation at controlled submergence of 5 to 13.8 inches and at max 72 RPM, so that the oxygen transfer rate and power requirements can be varied with the flow and treatment requirements.
3. The Standard Aeration Efficiency (SAE) at maximum of 72 RPM and maximum immersion 13.8-inch shall be 3.32 lb O₂/BHP/hr.
4. A process control system shall be provided to monitor and control dissolved oxygen levels in the Oxidation Ditch system installed in each aeration channel.
5. Total of six (6) 30 HP complete rotary aerator assemblies as shown on the Drawings.
6. The existing rotors with of 15 ft of aeration blades, located as shown on the Drawings and determined by the Manufacturer to provide the required oxygen requirements.

D. Aerator Shafting (re-use existing)

E. Bearings

1. Each aerator shaft shall be supported by self-aligning, grease lubricated, roller bearings with cast iron pillow block housings. Housings shall be coated for corrosion protection according to this proposal. Each bearing shall have double row spherical roller bearings with locking collars to secure the bearing to the shaft. Heavy duty contact seals shall be provided to insure positive sealing against contaminants. The seals shall be designed for operation in a moisture laden environment.
2. Minimum B-10 bearing life shall be 200,000 hours.

F. Drive

1. A shaft-mounted, double-reduction reducer with alloy steel high hardness helical gearing, positive splash-type lubrication and double lip oil seals, shall be keyed to the inboard Rotor stub shaft.
2. The Rotor stub shaft shall be supported by the inboard pillow block bearing and extended through the reducer hollow bore and centered and held firmly in place by tapered bushings on each side of the reducer. Use of set screws and collar to lock gear reducer to shaft will not be acceptable.
3. Shaft mounted reducer shall have not less than a Class II rating based on motor horsepower.
4. Reducer shall be held in position by a torque arm and torque arm bracket. Torque arm bracket shall be fastened with cast-in-place anchors. Expansion anchors will not be acceptable.
5. A visual oil level gauge and oil filler tube for the reducer shall be mounted on the reducer.
6. Construction shall ensure concentric mounting of the reducer and free the reducer bearing and seals from shocks that may be generated in the Rotor.
7. The drive assembly shall be protected from Rotor splash by the parapet wall and splash plate.
8. Base-mounted gear reducers which support the Rotor loads on the gear reducer output shaft bearings and which are not belt driven will not be acceptable.
9. Power transmission from the motor to the reducer shall be by means of a set of V-belts and sheaves. Belts and sheaves shall be designed with a minimum 1.5 service factor based on motor horsepower.
10. Sheaves shall be two section units for both drive and driven sheaves and shall consist of a tapered split shaft bushing with three tapped holes to which the sheave is attached by three cap screws. Changing sheaves shall not require a wheel puller.

11. Belts and sheaves shall be provided for each Rotor assembly to meet the design conditions required in paragraph 1.05.
 12. Belts and sheaves shall be covered with a fabricated steel belt guard with expanded metal front panel in accordance with OSHA standards.
- G. Torque Tube shall be built of 14-inch diameter steel with a minimum of 0.375-inch wall thickness and shall have flanged ends. The torque tube material shall be ASTM-A106, Grade B steel or better.
- H. Stub shafts shall be fabricated of not less than ASTM-A36 steel. Stub shaft flanges shall be ASTM-A536
- I. Fiberglass Weather Protection (existing reused)
- J. Anchors and Hardware
1. All anchor bolts shall be 304 stainless steel and furnished by the Manufacturer and set with proper projection by the Contractor in accordance with approved, certified drawings furnished by the Manufacturer.
 2. All hardware shall be 304 stainless steel.

2.3 SURFACE PREPARATION AND PAINTING

- A. Shop Surface Preparation
1. Electric motors, speed reducers, and other self-contained or enclosed components shall have the original manufacturer's standard enamel finish.
 2. Apply rust preventative compound to all machined, polished, and nonferrous surfaces which are not to be painted.
 3. All fabricated carbon steel or cast iron components for submerged service shall be near-white blast cleaned per SSPC-SP10 and given a 2.5 to 3.5 mil dry film thickness coat of Tnemec Series 1 Omnithane Primer.
 4. All fabricated carbon steel or cast iron components for non-submerged service shall be commercial blast cleaned per SSPC-SP6 and given a 2.5 to 3.5 mil dry film thickness coat of Tnemec Series 1 Omnithane Primer.
- B. Field Painting (Stub shafts)
1. All fabricated carbon steel or cast iron components for submerged service shall be near-white blast cleaned per SSPC-SP10 and given a 2.5 to 3.5 mil dry film thickness coat of Tnemec Series 1 Omnithane Primer.

2.4 MEDIUM-SPEED SUBMERSIBLE MIXER

- A. Major mixer components, unless otherwise specified, shall be gray cast iron, class 40, with smooth surfaces devoid of blowholes and other irregularities.
- B. The submersible mixers, total of 2 (one mixer per Oxidation Ditch) shall be equipped with minimum 12.2 hp motor, 480V/ 3ph /60 Hz and 1.15 service factor. New VFDs for the mixer's motors shall be provided in a separate panel by the Contractor.
- C. Each mixer shall be of the integral-gear, close-coupled, submersible type. Direct-drive mixers shall not be acceptable for this project. All components of the mixer, including the motor and speed

reducer, shall provide continuous underwater operation while the mixer blades are completely submerged.

- D. The mixer shall be capable of handling typical domestic or industrial raw, screened wastewater with normal concentrations of rags, strings, and sand/grit. The mixer shall be designed to be raised, lowered and removed for inspection or service without personnel having to enter the tank. A sliding guide bracket shall be an integral part of the mixer unit. The entire weight of the mixing unit shall be guided by the guide bracket, which shall handle all thrust created by the mixer. The mixer, with its appurtenances and cable, shall be capable of continuous submergences without loss of watertight integrity to the depth of the oxidation ditch.
- E. All mating surfaces where watertight sealing is requested shall be machined and fitted with nitrile rubber O-rings. Fittings shall be such that sealing is accomplished by metal-to-metal contact between machined surfaces, resulting in compression of the O-rings without secondary sealing compounds, rectangular gaskets, elliptical O-rings, grease, or other devices shall be used.
- F. The cable entry shall be an integral part of the stator casing. The cable entry shall be composed of a conical cable holder with a flange bearing against a shoulder in the stator-casing opening. The cable entry cone shall be of gray cast iron AISI A48-40B. Sealing shall be accomplished by a metal-to-metal contact between machined surfaces resulting in compression of the O-ring. The cable shall be cast into the cable entry cone providing a leak-proof, torque-free seal at the cable entrance. No terminal board in the motor shall be required.
- G. Each mixer shall be provided with a grease chamber in the propeller hub for the shaft sealing system, and a second separate oil chamber for the gearbox. Drains and inspection plugs shall be provided with positive anti-leak seal and shall be accessible from the outside.
- H. The mixer motors shall be squirrel-cage, induction type design, housed in an air-filled, watertight chamber.
- I. The stator winding shall be insulated with moisture resistant Class F insulation, which shall resist temperatures of 315°F. The stator shall be dipped and baked three times in Class F varnish. The motor shall be designed for continuous-duty, capable of sustaining a maximum of 10 evenly spaced starts per hour. The rotor bars and short circuit rings shall be made of aluminum. The motor shaft designed with the rotor as an integral part, shall be shaft steel AISI 4340. The stator housing shall be of gray cast iron AISI AS48-40B.
- J. Bimetallic thermal sensor, mounted in the stator windings end turns and wired into the mixer control, shall monitor temperature. These shall supplement the external motor over current protection located in the control panel. The thermal sensors are of the normally closed type, rated at 216°F.
- K. The mixer motor shaft shall rotate on two permanently lubricated bearings. The inner and outer bearing shall be single row, deep-groove ball bearings calculated for an AFBMA L-10 theoretical design life of 100,000 hours at full load.
- L. The speed reducer shall be a one-stage planetary reduction gear, equipped with high precision, low-loaded gears designed for infinitive life. The motor shaft shall be provided with spline to attach to the speed reducer. The reduction stage shall consist of an integral toothed ring gear to which three planet wheels are mounted on the planet carriers, engaging with the sun pinion. The gear shaft shall be identical with the propeller shaft. Gear casing shall be gray cast iron AISI A48-40B.

- M. A guide rail system shall be used to mount each mixer during operation and to guide the units during installation and removal for service. The system shall consist of a bottom anchorage assembly, stop console, guide pipe, fixing bracket and guide holder assembly. All major components shall be constructed of AISI Type 304 stainless steel. They shall be used in connection with a 3-inch or 4-inch square guide pipe as recommended by the manufacturer.
- N. The bottom anchorage assembly shall be bolted to the floor of the tank and provide support for the guide pipe. It shall also include a receptacle to accept the guide pipe bottom pivot. The guide pipe must be strong enough to absorb the mixer reload force. The bottom anchorage assembly and guide pipe shall be constructed of AISI Type 304 stainless steel.
- O. The mixer stop console shall be fastened to the guide pipe using high-strength stainless steel bolts. The console shall be strong enough to support the weight of the mixer. The console shall be positioned in such a manner to prevent the mixer blade tips from hitting the basin floor. The console shall be constructed of AISI Type 304 stainless steel.
- P. The upper guide holder assembly shall secure the system to the concrete platform. It shall consist of a fixing bracket and upper guide holder. The system shall provide the lateral support for the guide pipe allowing the possibility of the guide pipe to be positioned at any reasonable angle for flow and energy optimization. Pre-set stops are not acceptable for this project. The upper guide holder assembly shall be constructed of stainless steel. The assembly shall contain a device to secure the electrical motor cable holder, and it shall be fabricated of AISI Type 304 stainless steel.
- Q. Two portable crane arm assemblies shall be provided to raise and lower the mixers for installation and service as noted in paragraph 1.03.E.3. Removable crane arm shall consist of an arm with telescopic capabilities, a spur gear or worm gear hand winch with brake for load control with stainless steel wire and a hook.
- R. The crane arm assembly shall be constructed of AISI Type 304 stainless steel. It shall be suitable for bringing the mixers out of the water and positioning it for safe, efficient service.

2.5 INSTRUMENTATION AND CONTROLS

- A. The control system shall contain all interlocks, alarm functions and aerator control as required for operation of the Oxidation Ditch system. It shall be furnished by Lakeside or pre-qualified and approved Equal.
- B. System Function
 - 1. The system shall be designed to monitor dissolved oxygen (DO) and control oxygen delivery based on the process objectives.
 - 2. All of these functions shall be incorporated in a single package from the same Manufacturer of the oxidation ditch system.
- C. Control Panel – A control panel shall be supplied and will include the following:
 - 1. The contractor shall furnish, install and commission a Remote PLC Panel (MCP-200A), refer to electrical drawings for panel location. For exterior installation locations see Specification 409601. For interior installation locations see Specification 409602.
 - 2. The contractor shall furnish, install and commission a separate Motor Control Panel (MCP-200B) for VFDs/ motor starters as outlined. Refer to electrical drawings for panel location

and mounting requirements. The enclosure shall be NEMA 4X SS for exterior locations and NEMA 4 for interior locations.

3. The motor control panel shall include but limited to: VFDs / motor starters as outlined, power supply, main 3 phase disconnect C/W front door handle, breakers, fuses, line reactors, terminals, etc. Provide adequate panel heating/cooling to meet panel interior components environmental requirements. All VFDs shall communicate with Remote PLC Panel via Ethernet. Each VFD shall have a front door mounted HIM module. Each motor (VFD/Motor Starters) shall have a front door mounted HOA with green run indicator light and red fault indicator light. VFD manufacturer shall be AB Powerflex or approved equivalent.
4. Corrosion inhibitors will be provided, Hoffman AHCI10E or equal.
5. The PLC shall contain input/output points for the following equipment and instruments. Analog inputs and outputs shall be of the 4-20 mA type.

Equipment	Quantity
Aerator VFD	6
DO Probe	2
Influent Gates	2
Influent Valves	2
RAS Valves	4
Mixers	2

6. VFD Points: DI-Run; DO-Start, AO-Speed Control.

- D. Control panel shall include all required power supplies for DC circuits. Power supplies shall be Phoenix Contact, Sola or equal.
- E. Surge Arrestors shall be provided for any analog circuits that originate from outside of the control panel building, surge arrestors shall be Phoenix Contact TT, EDCO PC series or equal.
- F. Where used, operator indicating lights, selector switches and pushbuttons shall be industrial duty, rated NEMA 4X, and be 30.5mm nominal size with required nameplates. Pilot lights shall be of the LED push to test type, color as required. Operator devices shall be Siemens Class 52 Series, Allen Bradley, Square D or equal.
- G. Relays supplied shall be industrial plug-in type, minimum DPDT, with contacts rated for 10 amps. Relays shall be Phoenix Contact, IDEC, Potter Brumfield or equal.
- H. Timers shall be multi-range, multi-function, industrial plug-in type. Timers shall be IDEC RTE, Siemens or equal.
- I. All wiring in the control panel shall be in wire-ways or suitably tie-wrapped to provide for neat appearance. Internal wiring shall be color coded. All wires which connect outside the panel shall terminate on NEMA rated terminal blocks. Terminal Blocks shall be Phoenix Contact UT, WAGO or equal.
- J. Provide in control panel a Phoenix Contact or N-TRON 4 port (RJ45, 10/100) network switch for interface to the plant SCADA system provided by others.

2.6 INSTRUMENTS

- A. Manufacturer shall supply one (1) Dissolved Oxygen (DO) probe for each aeration channel with analyzer/transmitter. The DO probes shall be Hach LDO.
- B. Manufacturer shall supply one (1) Hach SC4500 transmitter. It shall have separate 4-20 mA outputs for each sensor. The transmitter(s) shall have separate 4-20 mA outputs for each sensor for transmission of each signal to the PLC.
- C. The probe handrail mounting kit shall, provided by the Contractor as shown in general arrangement drawings.

2.7 CONTROL PROGRAMMING

- A. The aeration program shall control using a system approach. Oxygen delivery to the entire process shall be determined using all sensor inputs rather than each sensor control aerators in discrete reactors.
- B. Standard I/O List
 - 1. Analog Inputs:
 - a. DO #1
 - b. DO #2
 - 2. Analog Outputs
 - a. Aeration Motor VFD #1-#6 speed command
 - b. Mixer motor VFD 1 & 2 speed command analog outputs.
 - 3. Digital Inputs:
 - a. Aeration Motor VFD #1-6 Running
 - b. Aeration Motor VFD #1-6 Fail.
 - c. Mixer Motor #1-2 Running
 - d. Mixer Motor #1-2 Fail.
 - 4. Digital Outputs
 - a. Aeration Motor VFD #1-6 Start
 - b. Mixer Motor #1-2 Start

2.8 ELECTRIC MOTOR

- A. Supply each premium efficiency polyphase electric motor in accordance with NEMA and IEEE standards rated for 230/460 volts, suitable for severe duty applications and VFD rated with all of the following requirements:
 - 1. Totally enclosed fan cooled with epoxy enamel finish coat.
 - 2. All cast iron structural parts.
 - 3. 1.15 service factor.
 - 4. 30 Hp, 1750 nominal RPM
- B. Polyphase electric motors shall be Baldor, WEG or Tech Top type or equal.
- C. Thermal switches embedded in the stator winding end-turns shall be used to monitor motor over-temperature.

- D. All continuous rated polyphase electric motors shall be of the "energy efficient type". Efficiency and losses shall be determined in accordance with the latest IEEE Standard 112 and NEMA Motor Generator Standards MG1-12.53a and MG1-12.53b.

2.9 SPARE PARTS

- A. Manufacture shall provide the following spare parts:
 - 1. One (1) of each type and size Bearings (fixed and floating)

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verification of existing conditions before starting work.
- B. Verify that equipment anchors are correctly positioned.

3.2 INSTALLATION

- A. Equipment shall be installed in accordance with GENERAL MECHANICAL REQUIREMENTS, and in accordance with the Manufacturer's recommendations to provide a complete installation.
- B. All grease fittings shall be mounted on main walkway handrails for ease of access.
- C. The Contractor shall level, align shafting, grout beneath bearing base plates, install drives, aeration discs and accessories in accordance with the Manufacturer's drawings and installation manual.
- D. Touch up minor damaged surfaces caused during installation. Replace damaged components as directed by Engineer.

3.3 ELECTRICAL

- A. Unless noted otherwise all motor starters, fusible safety switches, selector switches, and pushbuttons will be supplied, mounted and wired in Division 16, Electrical Work, as indicated on the Drawings.
- B. All electrical equipment supplied in this Item shall conform to Division 16 Electrical Work.
- C. All electrical equipment, conduit and wiring not indicated on the Drawings, but necessary to provide a complete operating system shall be provided at no additional cost to the Owner.
- D. Electrical Wiring: The external conduit and wiring required for power and control to electrical equipment shall be supplied and installed in Division 16, Electrical, as indicated on the drawings.
- E. Electrical Devices, Operational Controls, Sequence of Operation:
 - 1. Coordinate installation with other electrical wiring as required.

3.4 INTERFACE WITH OTHER PRODUCTS

- A. Coordinate installation with existing plant operation and effluent discharge.
- B. Provide a SCADA interface to enable the transmission of the oxidation ditch status to the SCADA PLC. The panel shall communicate using Ethernet IP protocol.

3.5 INSPECTION, STARTUP, AND O&M INSTRUCTIONS

- A. Start-up Services - Furnish the services of a qualified manufacturer's representative for a period of not less than two (2) days to inspect and adjust the equipment furnished in this Item, and to make such tests on the equipment as are necessary to insure satisfactory operation. Start-up is to occur after all new treatment plant modifications are fully operational.
 - 1. Check shaft and bearing alignment.
 - 2. Provide documentation that equipment runs as designed with both automatic, manual and SCADA digital input controls including automatic adjustment of speed of aerators from ORP and DO signal.
- B. After the equipment is in continuous satisfactory operation, furnish the services of a qualified manufacturer's representative for a period of not less than one 8-hour day for the sole purpose of instructing the Owner's personnel in the care and operation of this equipment. This time shall be separate from that time to start up and/or adjustment of the equipment.
- C. The manufacturer of the oxidation ditch aeration system equipment shall provide a representative to check the installation, make final adjustments, and supervise initial startup of the equipment.
- D. The representative shall instruct the Owner's personnel in the operation and maintenance of the equipment.

END OF SECTION 465361

SECTION 466600 - ULTRAVIOLET DISINFECTION EQUIPMENT

PART 1 - GENERAL

1.1 SCOPE OF WORK

- A. Furnish all labour, materials, equipment, and appurtenances required to provide an open channel, gravity flow, low pressure high intensity ultraviolet lamp (UV) disinfection system complete with an automatic mechanical/chemical cleaning system and variable output electronic ballasts. The UV system to be complete and operational with all control equipment and accessories as shown and specified herein. This system will be capable of disinfecting effluent to meet the water quality standards listed in this section.
- B. The system to be installed by the Contractor and tested and commissioned by the manufacturer. The Owner will consider alternates if all requirements of this specification are met without exception including Pre-qualification Requirements in Section 1.3 Quality Assurance.

1.2 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specifications sections, apply to work of this section.

1.3 QUALITY ASSURANCE

- A. Pre-qualification Requirements: Any alternate UV manufacturer that is not named or listed as approved equal must submit the following 15 days prior to bid to be considered for approval:
 - 1. To be considered, the manufacturer will be regularly engaged in the manufacture of UV systems with a proven track record of at least two hundred (200) operating installations of the proposed UV system.
 - 2. The manufacturer will provide documentation of previous experience with municipal UV disinfection systems in wastewater applications with variable output electronic ballasts.
 - 3. Pre-qualification submittals from manufacturers will include a complete and detailed proposal of equipment offered, including the number of lamps proposed and a detailed description of any exceptions taken to the specification.
 - 4. To be considered, the manufacturer will submit a bioassay evaluation for the proposed reactor, without exception. The bioassay will have been completed by an independent third party and have followed protocols described in the NWRI Ultraviolet Disinfection Guidelines for Drinking Water and Water Reuse (May 2003) and/or applicable sections of the US EPA Design Manual – Municipal Wastewater Disinfection (EPA/625/1-86/021) using MS2 bacteriophage. The bioassay must demonstrate that the proposed UV system design and number of lamps will deliver the specified dose.
 - 5. Independent certification of fouling factor and lamp aging factor must be submitted if values other than the specified default values are being proposed.

6. Documentation of UV manufacturer's service capabilities including location and experience.
7. Sample disinfection performance guarantee including scope and duration of guarantee.
8. All UV manufacturers will be required to pre-qualify unless the manufacturer is the base bid manufacturer.

B. Design Criteria:

1. Provide equipment that will disinfect effluent with the following characteristics:
2. Current Peak Flow: 6 MGD
3. Future Peak Flow: 12 MGD
4. Minimum Flow: 0.33 MGD
5. Total Suspended Solids: 5.4 mg/L, 30-day average, grab samples.
6. Effluent Temperature Range: 33 to 85 °F (1 to 30 °C)
7. UV Transmittance @ 254 nm: 65%, minimum
8. Maximum Mean Particle Size: 30 microns
9. Effluent standards to be achieved: 126 E. coli/100 ml based on a 30-day geometric mean of grab samples for the effluent standard.
10. Effluent standards shall be guaranteed regardless of influent count to UV system.
11. Validation Factors:
 - a. 0.98 end of lamp life factor (low-Pressure Amalgam Lamps)
 - b. 0.95 fouling factor (ActiClean-WW™ Chemical/Mechanica Cleaning System)
12. The UV system is to be installed in 1 open channel having the following dimensions:
 - a. Length: 25 ft-5 1/4 inch.
 - b. Width: 16 in.
 - c. Side Water Depth: 2.86 ft
 - d. Channel Hight: 7.75 ft
13. System configuration:
 - a. The UV system must fit within the UV channels as stated without modification.
 - b. The UV system configuration will be as follows:
 - 1) Number of Channels: 1
 - 2) Number of Banks per Channel: 2
 - 3) Number of UV Modules per Bank: 4, manufacture to provide stretch for the frame to accommodate specified channel hight.
 - 4) Number of Lamps per UV Module: 8
 - 5) Total Number of Lamps in the UV System: 64
 - 6) Number of System Controllers: 1
 - 7) Number of UV Detection Systems: 2
 - 8) Number of Power Distribution Centers: 2
 - 9) Number of Level Controllers: 1

C. Performance Requirements:

1. The ultraviolet disinfection system will produce an effluent conforming to the following discharge permit: 126 E. coli/100 ml based on a 30-day geometric mean of grab samples. Grab samples will be taken in accordance with the Microbiology

Sampling Techniques found in *Standard Methods for the Examination of Water and Wastewater, 19th Ed.*

2. Provide a UV disinfection system complete with UV Banks, System Control Center, Power Distribution Centers, Support Racks and Level Controller as shown on the contract drawings and as herein specified.
3. The UV system will be designed to deliver a minimum UV dose of 30 mJ/cm² at peak flow, in effluent with a UV Transmission of 65% at end of lamp life (EOLL) after reductions for quartz sleeve fouling. The basis for evaluating the UV dose delivered by the UV system shall be the independent third-party bioassay using MS2 bacteriophage, without exception. Bioassay validation methodology to follow protocols described in NWRI *Ultraviolet Disinfection Guidelines for Drinking Water and Water Reuse* (May 2003/Aug 2012) and/or applicable sections of the US EPA Design Manual – Municipal Wastewater Disinfection (EPA/625/1-86/021).
4. The UV Dose will be adjusted using an end of lamp life factor of 0.5 to compensate for lamp output reduction over the time period corresponding to the manufacturer's lamp warranty. The use of a higher lamp aging factor will be considered only upon review and approval of independent third party verified data that has been collected and analysed in accordance with protocols described in NWRI *Ultraviolet Disinfection Guidelines for Drinking Water and Water Reuse* (May 2003).
5. The UV Dose will be adjusted using a quartz sleeve fouling factor of 0.8 when sizing the UV system in order to compensate for attenuation of the minimum dose due to sleeve fouling during operation. The use of a higher quartz sleeve fouling factor will be considered only upon review and approval of independently verified data that has been collected and analysed in accordance with protocols described in NWRI *Ultraviolet Disinfection Guidelines for Drinking Water and Water Reuse* (May 2003).
6. Independent Validation for use of higher factors (lamp aging and sleeve fouling) must be submitted to the Engineer a minimum of fifteen (15) days prior to bid.
7. The system shall be able to continue providing disinfection while replacing UV lamps, quartz sleeves, ballasts and while cleaning the UV lamp sleeves.
8. The system shall be designed for complete outdoor installation.

1.4 SUBMITTALS

A. Submit for review, shop drawings showing the following:

1. Complete description in sufficient detail to permit an item comparison with the specification.
2. Dimensions and installation requirements.
3. Descriptive information including catalogue cuts and manufacturers' specifications for major components.
4. Electrical schematics and layouts.
5. Hydraulic calculations demonstrating compliance with the required hydraulic characteristics.
6. Independent bioassay validation and dosage calculations demonstrating compliance with the specified dose requirements.
7. UV treatment performance guarantee.

1.5 WARRANTY

- A. The equipment furnished under this section will be free of defects in material and workmanship, including damages that may be incurred during shipping for a period of 12 months from date of start-up or 18 months after shipment, whichever comes first.
- B. The UV lamps to be warranted for a minimum of 12,000 hours when operated in automatic mode, prorated after 9,000 hours. On/off cycles are limited to ten (10) per day.
- C. Ballasts to be warranted for 5 years, prorated after 1 year.

PART 2 - PRODUCTS

2.1 MANUFACTURER

- A. Acceptable Manufacturers
 - 1. UV3000Plus™ System by Trojan Technologies
 - 2. Engineer approved equal.
- B. If other equipment is proposed, the Contractor will demonstrate to the Engineer and the Owner that all requirements of materials, performance, and workmanship have been met or exceeded by the equipment proposed. Contractors proposing alternate manufacturers will be responsible for all costs associated with system evaluation and redesign including all electrical, mechanical and civil aspects of the installation.
- C. UV manufacturers using panel-mounted electronic ballasts shall be located in NEMA 4X stainless steel, air-conditioned cabinets supplied with sun-shade or shall be located in NEMA 12 enclosures located inside a fiberglass building having appropriate air-conditioning and lighting. For other specified UV manufacturers using compressed air-powered quartz sleeve wiping systems, the Contractor shall be responsible to provide an ASME receiver tank with duplex compressions mounted on the receiver tank, as well as air compressor control panel and air dryer. Receiver tank shall include solenoid-type, automatic condensate blow-down valves.

2.2 DESIGN, CONSTRUCTION AND MATERIALS

- A. General:
 - 1. All module welded metal components in contact with effluent shall be Type 316 stainless steel.
 - 2. All metal components above the effluent shall be Type 304 stainless steel with the exception of the ballast enclosure, which is constructed of anodised aluminium.
 - 3. All wiring exposed to UV light shall be Teflon™ coated.
 - 4. All wires connecting the lamps to the ballasts shall be enclosed inside the frame of the UV Module and not exposed to the effluent.
- B. Lamp Array Configuration:
 - 1. The lamp array configuration shall be the uniform array with all lamps parallel to each other and to the flow.

2. The system shall be designed for complete immersion of the UV lamps including both electrodes and the full length of the lamp tube in the effluent.

C. UV Module:

1. Each UV module shall consist of UV lamps with an electronic ballast enclosure mounted on a Type 316 stainless steel frame.
2. Each lamp will be enclosed in its individual quartz sleeve, one end of which shall be closed and the other end sealed by a lamp end seal.
3. The closed end of the quartz sleeve shall be held in place by means of a retaining O-ring. The quartz sleeve shall not come in contact with any steel in the frame.
4. The ends of the lamp sleeve shall not protrude beyond the stainless steel frame of the UV Module.
5. Lamp wires shall terminate in the electronic ballast enclosure located at the top of the UV Module.
6. All lamp to ballast connections shall be made by and tested by the UV Manufacturer.
7. The electronic ballast enclosure shall contain the electronic ballasts and addressable lamp status monitoring systems.
8. Each UV Module shall be connected to a receptacle on the Power Distribution Center.
9. At the point of exit from the UV Module frame the multi conductor cable shall pass through a waterproof strain relief.
10. Each UV module shall have a rating of Type 6P.

D. Integrated Lamp Assembly

1. Each integrated lamp assembly to be water-proof and shall comprise of a UV lamp, quartz sleeve and integrated connector.
2. UV Lamps
 - a. The UV lamp forms part of the complete integrated lamp assembly.
 - b. Lamps will be high intensity low pressure amalgam design. The lamp will be preheated to promote longevity. Lamps that are not amalgam or that are based on driving a low pressure lamp at amperages greater than 500 milliamps will not be allowed.
 - c. The filament will be of the clamped design, significantly rugged to withstand shock and vibration.
 - d. Electrical connections will be at one end of the lamp and have four pins, dielectrically tested for 2,000 Vrms. Lamps that do not have 4 pins will be considered instant start. To be considered as an alternate, instant start lamp systems will supply replacement spare lamps equal to 50% of the total number of lamps in the system.
 - e. Lamps shall be operated by electronic ballasts with variable output settings.

E. UV Lamp Quartz Sleeves:

1. The UV quartz sleeve forms part of the complete integrated lamp assembly.
2. Type 214 clear fused quartz circular tubing as manufactured by General Electric or equal.
3. Lamp sleeves shall be domed at one end.
4. The nominal shall thickness will be 1.5 mm.

- F. Lamp Socket
1. The lamp socket shall be sealed against the module leg sleeve cup by means of an O-ring.
 2. The O-ring seal around the lamp socket shall isolate and seal the lamp assembly from the module frame and all other lamps in the module.
 3. In the event of a quartz sleeve fracture the integrated connector of the lamp assembly will prevent moisture from entering electrical contacts of the lamp socket, lamp module frame and the electrical connections to the other lamps in the module.
- G. UV Module Support Rack:
1. The UV module support rack shall be minimum Type 304 stainless steel and be mounted above the effluent in the channel allowing adjustment to the precise height of the channel.
- H. Effluent Level Controller:
1. Level Control Weir
 - a. Located at the discharge end of the UV channel.
 - b. Designed to maintain a minimum channel effluent level as required to keep lamps submerged.
 - c. Constructed of Type 304 stainless steel.
- I. Low Water Level Sensor:
1. One low water level sensor shall be provided by the UV Manufacturer for the UV channel.
 2. During manual, automatic and remote modes of system operation, the water level sensor shall ensure that lamps extinguish automatically if the water level in the channel drops below an acceptable level.
 3. The low water level sensor shall be powered by the level control panel that is powered by the PDC.
- J. Electrical
1. Each UV module within a bank shall be powered from the bank's dedicated Power Distribution Center.
 2. UV manufacturer to supply all cabling and conduit between lamps and ballasts.
 3. UV manufacturer to perform all terminations between lamps and ballasts.
 4. Each electronic ballast within a UV module will operate two lamps.
 5. Power factor will not be less than 98% leading or lagging.
 6. Electrical supply to each Power Distribution Center shall be 480/277V, 60 Hz, 8.2 kVA.
 7. Electrical supply to the Hydraulic System Center shall be 480V / 60 Hz, 2.5 kVA.
 8. Electrical supply for the water level sensor shall be provided by the PDC(s) and be 24 Volt DC.
 9. Electrical supply to the System Control Center shall be 120V 1 Ph, 2 Wire + Gnd, 60 Hz, 1.8 kVA service.
 10. The Contractor shall provide electrical disconnects for the UV system. Each electrical power supply should be provided with a separate disconnect to be

supplied under the electrical contract. Contractor shall provide an external disconnect near-by to PDC.

K. Power Distribution Center:

1. Power distribution shall be through environmentally sealed receptacles on the PDC(s) to allow for local connection of UV modules.
2. Data concentration shall be through integrated circuit boards located inside the Power Distribution Center.
3. PDC enclosure material shall be Type 304 stainless steel.
4. All internal components will be sealed from the environment.
5. All Power Distribution Centers to be UL approved or equivalent with a rating of Type 4X.
6. One separate sealed Power Distribution Center shall be provided per bank of lamps.
7. To be considered as an alternative, systems that have ballasts mounted in cabinets, the UV manufacturer shall provide one complete cabinet for each bank of lamps, to ensure that each bank is electrically isolated for safety during maintenance and to provide redundancy under average flow conditions.

L. Control and Instrumentation:

1. The contractor shall furnish, install and commission a Remote PLC Panel (MCP-400A), refer to electrical drawings for panel location. For exterior installation locations see Specification 409601. For interior installation locations see Specification 409602.
2. System Control Center (SCC):
 - a. The operation of the UV3000Plus™ is managed at the SCC by PLC-based controller which continuously monitors and controls the system functions. PLC shall be model Compact Logix as manufactured by Allen Bradley.
 - b. The operator interface display screen shall be 12-inch color, touch-screen menu-driven with automatic fault message windows appearing upon alarm conditions. Operator Interface will be Beijer model X2 Extreme -Type 4X, Outdoor Rated.
 - c. Alarms shall be provided to indicate to plant operators that maintenance attention is required or to indicate an extreme alarm condition in which the disinfection performance may be jeopardized. The alarms will include but not be limited to:
 - 1) Lamp Failure
 - 2) Multiple Lamp Failure
 - 3) Low UV Intensity
 - 4) Module Communication Alarm
 - d. The 100 most recent alarms will be recorded in an alarm history register and displayed when prompted.
 - e. Bank status will be capable of being placed either in Manual, Off or Auto mode.
 - f. Elapsed time of each bank will be recorded and displayed on the display screen when prompted.
 - g. Digital I/O modules shall be provided to remotely indicate status and alarms such as:
 - 1) Alarm conditions (critical, major, minor)
 - h. A 24 VDC PLC UPS with 15-minute program back-up shall be included.

i. PLC shall provide Ethernet connection for SCADA

M. UV Intensity Sensor

1. A submersible UV sensor shall continuously monitor the UV intensity produced in each bank of UV lamps.
2. The sensor shall measure only the germicidal portion of the light emitted by the UV lamps. The intensity sensor shall be factory calibrated. Intensity sensors that can be field calibrated will not be permitted.
3. The UV intensity sensor must adhere to the criteria outlined in the USEPA UV Disinfection Guidance Manual (UVDGM) for intensity sensors including germicidal response, accuracy and NIST traceability.

N. Dose-Pacing:

1. A dose-pacing system shall be supplied to modulate the lamp UV output in relationship to a 4-20 mA DC signal from an effluent flow meter by Contractor.
2. The system to be dose-paced such that as the flow and effluent quality change, the design UV dose is delivered while conserving power.
3. The dose-pacing system will allow the operator to vary the design dose setting. Logic and time delays will be provided to regulate UV bank ON/OFF cycling.

O. Hydraulic System Center (HSC):

1. One (1) HSC shall be supplied to house all components required to operate the automatic cleaning system.
2. Enclosure material of construction shall be Type 304 stainless steel.
3. The HSC shall contain a hydraulic pump complete with integral 4-way valve and fluid.

P. Cleaning System:

1. An automatic cleaning system shall be provided to clean the quartz sleeves using both mechanical and chemical methods. Wiping sequence will be automatically initiated with capability for manual override.
2. The cleaning system shall be fully operational while UV lamps and modules are submerged in the effluent channel and energized.
3. Cleaning cycle intervals to be field adjustable.
4. Remote Manual and Remote Auto cleaning control options shall be provided.
5. The cleaning system shall be provided with the required solutions necessary for initial equipment testing and for equipment start-up.
6. The UV manufacturer shall be responsible for supplying all equipment including any equipment not specifically listed required to perform out of channel chemical cleaning. Contractor shall be responsible for installation.

Q. Module Lifting Device:

1. One Davit crane, base and module lifting sling shall be supplied to assist in removing individual modules from the effluent channel.
2. Lifting device shall be a crane with hand winch and will include an adjustable boom to ensure adequate reach and height.
3. Lifting device to include a swivel handle for rotation and positioning.

4. Crane and base shall be supplied by the Manufacturer and shall be installed by the Contractor.

2.3 SPARE PARTS AND SAFETY EQUIPMENT

- A. Manufacturer shall provide the below list of spare parts.
- B. Spare parts shall be protected and packaged as recommended by the Manufacturer. Each package shall be tagged for positive identification noting: part name, part number, associated equipment name and number, Manufacturer name and address.
- C. Spare Parts: The following spare parts and safety equipment to be supplied.
 1. Four (4) UV Lamps
 2. Two (2) Quartz Sleeves
 3. Two (2) Ballasts
 4. Eight (8) UV Wiper Seal Kits
 5. One (1) Set Protector Caps
 6. One (1) Operators kit including face shield, gloves and cleaning solution.
 7. One (1) 304 SST UV Module maintenance rack.
- D. Manufacturer shall furnish all special tools required for the proper installation, operation and maintenance of any component of the UV System.
- E. All spare parts and safety equipment are to be separately packaged. All packages are to be marked with quantity, item description and part number.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Equipment shall be installed by Contractor in accordance the manufacturer's recommendations, drawings and specifications to provide a complete installation.
- B. Operation and Maintenance (O&M) Manuals shall be provided by the equipment Manufacturer at least two (2) weeks prior to shipment of all major equipment components. The O & M Manuals shall include instructions on storage, installation, start-up, and operation and maintenance, together with a complete parts list and a recommended spare parts list.
- C. The manufacturer shall provide installation assistance and certification as required for proper installation prior to start-up.
- D. The Contractor shall be responsible for furnishing and placing all anchorage systems (bolts, nuts, washers, gaskets and any other items necessary) for the installation of the equipment. The Contractor shall coordinate with the Manufacturer in identifying proper size and locations of all anchorage.

3.2 DELIVERY, STORAGE, AND HANDLING OF EQUIPMENT

A. Delivery and storage shall be done per Section 016600.

3.3 FIELD CONSTRUCTION QUALITY CONTROL MANUFACTURER'S SERVICES

A. The equipment manufacturer shall provide factory testing per Section 013326.

B. The equipment manufacturer shall provide Instruction of Owner's Personnel per Section 017902.

C. Start-up and Field Services shall be scheduled upon written request. Contractor shall notify Manufacture.

D. A qualified representative of the Manufacturer shall inspect the completed installation, service the equipment, adjust, field test, operate the equipment under all design conditions, instruct the Owner's personnel in proper operating and maintenance procedures, and provide the Owner with a written certificate of approval.

E. The equipment manufacturer shall provide a qualified representative following installation for at least two (2) 8-hour days performing the required services and submit a Manufacturer's representative report. The training shall be separate from the specified service time spent on site and shall consist of at least one (1) 8-hour day on a date agreed upon by the Owner in writing at least two weeks in advance.

3.4 OPERATION AND MAINTENANCE MANUALS

A. Operation and maintenance (O&M) manuals shall be submitted and in accordance with Section 017823.

END OF SECTION 466600

SECTION 467321 – AERATION EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specifications sections, apply to work of this section.

1.2 DESCRIPTION OF WORK

- A. Work of this Section includes, but is not limited to work necessary to furnish and install following aeration equipment:
 - 1. Coarse bubble diffusers for the Aerobic Digesters No. 1-5 and Sludge Wet Wells.
 - 2. Fine bubble diffusers for the Post Aeration Tank
- B. The aeration equipment shall include, but not limited to all diffusers, drop pipe, air header and manifolds, distributors, assorted connections, valves, mounting equipment, supports and spacings to be furnished complete in compliance with Contract Documents.
- C. The Manufacturer shall furnish coarse and fine bubble diffusers as completely engineered systems suitable for the operating conditions as outlined in these Specifications.
- D. The Contractor shall furnish all labor, materials, and equipment required to install the aeration system. Installation shall be complete and ready for operation as shown on the contract drawings and specified herein.
 - 1. Aerobic Digesters No. 1-3: Existing air pipe is utilized from the Blowers No. 1-4, located in the Sludge Transport / Electric Building. Contractor shall provide all required drop pipes to the diffuser's connection, pipe supports, and butterfly valves at locations as shown on the Drawings.
 - 2. Aerobic Digesters No. 4-5: The Contractor shall provide all air piping from Blowers No. 4-5, main header, including all required drop pipes to the diffuser's connection, butterfly valves, pipe supports, and etc., as described herein and shown on the Drawings.
 - 3. Sludge Wet Well No. 1 & 2: Contractor shall provide all required air pipe connection to the existing main airline from Blowers No. 1-4, main header, drop pipes to the diffusers connections, butterfly valves as shown on the Drawings.
 - 4. Post Aeration Tank: Contractor shall provide all required air pipe connection to the existing main airline from Blowers No. 1-4, drop pipe to the diffuser's connection, butterfly valves as shown on the Drawings.
- E. All of the coarse and fine bubble diffusers shall be the product of the same manufacturer. The manufacturer shall provide test data proving that the aeration equipment will perform in accordance with the specifications when operated at the specified design conditions.
- F. Specific Site Conditions for the City of Sunbury WWTP, Ohio:
 - 1. Site Elevation: 971 ft
 - 2. Site Atmospheric Pressure: 14.19 psi

3. Design Temperature: 100°F
4. Humidity: 90%
5. Influent Wastewater Data:
 - a. Average Day Flow: 2.0 MGD
 - b. Peak Flow: 6.0 MGD
 - c. Influent CBOD: 160 mg/L

G. Definitions

1. SCFM: Standard cubic feet per minute is understood to be air at 68°F, 14.7 psia, and 36% relative humidity flowing at a rate of 1 cubic foot per minute.
2. SOTR: Standard oxygen transfer rate is the rate of oxygen transferred to tap water (pounds of oxygen per hour) at standard conditions of 20°C, 0.0 mg/l residual dissolved oxygen concentration, and a barometric pressure of 760 mm Hg (dry air).
3. SOTE: Standard oxygen transfer efficiency is the fraction of oxygen transferred to tap water under standard conditions of 20°C, 0.0 mg/l residual dissolved oxygen concentration, and a barometric pressure of 760 mm Hg (dry air).
4. Side Water Depth (SWD): Side water depth is the interior dimensions from the structure base to the water surface.

1.3 QUALITY ASSURANCE

- A. In addition to requirements of these specifications, comply with manufacturer's instructions and recommendations for work.
- B. General: The Contractor shall be responsible for ensuring that all is properly connected to other related equipment for proper functioning of the system.
- C. Manufacturer's Qualifications: The Manufacturers of work of this Section shall have 10 years minimum proven experience in such work and shall have satisfactorily completed 10 jobs of similar size and type within the last 5 years.
- D. The manufacturer shall perform following tests and provide certified calculations before shipment from the factory:
 1. Factory Test (for the Fine Bubble Diffusers only):
 - a. Clean Water Oxygen Transfer Efficiency. The manufacturer shall submit the test procedure with the shop drawing submittal package. The test procedure shall be in accordance with the latest version of the Procedures for Oxygen Transfer Testing by the ASCE Committee on Oxygen transfer Standards. The test shall be certified by a P. E. registered in the state where the test occurs.
 - b. Air Pressure Tests:
 - 1) Conduct pressure tests in conjunction with the factory oxygen transfer tests.
 2. Complete test data including certified oxygen transfer performance curves, sufficient to determine the oxygenation capacity of the coarse bubble diffuser aeration equipment proposed. The data supplied shall be for all tests conducted as specified herein. Testing facility arrangement shall be submitted to the Engineer for review prior to testing, and certified calculations shall be submitted to the Engineer subsequent to the SOTE testing. The Engineer shall be notified two (2) weeks prior to the test date so that the tests may be witnessed. Calculations showing the distribution and balancing of air to each zone within

each basin for the average and maximum airflow rates specified under Performance Requirements.

- E. The Manufacturer shall provide three (3) copies of all test results, including all initial measurements, computations, and final results. Test results provided shall be certified as to the accuracy of test performance as specified herein.

1.4 SUBMITTALS

- A. General: Submit the following in accordance with conditions of Contract and Division 1 Specification Sections.
- B. Product Data:
 - 1. Submit Manufacturer's literature, warranty, technical data and installation instructions complete with accessories, catalog cuts, performance data and curves, tests and certifications, drawings, specifications, fabrication details and parts identification for all work of this Section.
 - 2. Aeration system performance data including standard oxygen transfer efficiency.
 - 3. Diffuser, diffuser connector, and system headloss curves covering the range of airflow rates specified under Performance Requirements.
- C. Shop Drawings:
 - 1. Complete description of the coarse bubble diffuser aeration equipment which shall include the drop connections to the air manifolds, air manifolds, air distribution headers, diffusers, drain system, supports, anchorage details, expansion joints, air manifolds, header joints, gaskets, bolts, nuts and washers, and materials used.
 - 2. Detailed drawings of the proposed coarse bubble diffuser aeration equipment layout, showing all airline sizes and lengths, distances between air distribution headers, and the location of all holders, diffusers, supports, and expansion joints.
- D. Maintenance and Operating Instructions:
 - 1. Installation, Operation, and Maintenance Manual for the equipment specified herein shall contain as a minimum the following items:
 - a. Equipment Data Sheets
 - b. Installation Instructions
 - c. Operation and maintenance instructions
 - 1) Aeration system monitoring and maintenance
 - 2) Startup and test operations
 - 3) Normal operations
 - 4) Shutdown procedures
 - 5) Parts list
 - d. Aeration equipment shop drawings
 - e. Customer contact
 - 2. Submittal documents shall be transmitted in searchable electronic format and made available in bound hard-copy at the request of the Engineer or Owner.
 - 3. Any revisions during startup and testing which require revisions to the maintenance or operating instructions shall be made in each of the final copies prior to final payment being made to the Contractor.

1.5 DELIVERY, STORAGE AND HANDLING

- A. Fabricated manifolds shall not exceed 25 feet in length for shipping.
- B. Handling, delivery, and storage of the aeration equipment shall be in accordance with the Manufacturer's recommendations. No extra cost shall be charged the Owner for the handling, delivery, or storage of the equipment.

1.6 The aeration systems shall be designed by the manufacturer to transfer the following quantity of oxygen to clean water under standard conditions and at the specified air flow rate(s) as listed in Schedule A, Section 3.7.

- A. The manufacturer shall provide the required number of diffusers and adequately sized air piping to meet the specified oxygen transfer and headloss requirements. If more diffusers are required then specified elsewhere or shown on the drawings, then such diffusers shall be provided. Similar, if larger diameter manifold or drop piping must be furnished to meet the total system pressure drop, then there shall be no adjustments in price for the cost of extra diffusers, larger pipe or fittings.

1.7 WARRANTIES

- A. The warranty shall be for a minimum period of one (1) year from start-up or 18 months from time of equipment shipment, whichever comes first. The manufacturer's warranty shall cover all defects or failures of materials or workmanship which occur as the result of normal operation and service.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. The coarse bubble diffusers shall be in compliance with these specifications and plans and shall be supplied by the following manufacturer:
 - 1. SSI Aeration Diffusers, Reliaball (R-Ball-E) type.
 - 2. Aquarius Technologies Diffusers
 - 3. Or approved equal.
- B. The fine bubble diffusers shall be in compliance with these specifications and plans and shall be supplied by the following manufacturer:
- C. Fine Bubble Diffusers
 - 1. SSI Aeration
 - 2. Aquarius Technologies
 - 3. Or approved equal.

2.2 DESIGN INFORMATION

A. The aeration systems shall be designed by the manufacturer to transfer the following quantity of oxygen to clean water under standard conditions and at the specified air flow rate(s) as listed below. Maximum headloss of the diffusers and orifice as well as the entire system shall be as specified:

1. Coarse Bubble Diffusers: The coarse bubble diffusers shall be the EPDM 4-inch disc

	Units	Aerobic Digesters					Sludge Wet Well	
		No. 1	No. 2	No. 3	No. 4	No. 5	No. 1	No. 2
Diffuser Submergence	ft	8.75	8.75	13	12.25	12.25	9.25	9.25
Total Air Flow	scfm	529	632	1,021	1,134	1,134	178	178
Min SOTE/clear water	%/ft	0.875	0.875	0.86	0.88	0.88	0.875	0.875
Max. Head loss	inch WC	23	23	21	25	25	23	23

2. Fine Bubble Diffusers: The fine bubble diffusers shall be EPDM 9-inch disc.

	Units	Post Aeration Tank
Diffuser Submergence	ft	14
Total Air Flow	scfm	373
Min SOTE per clear water	%/ft	1.75
Max. Head loss	inch WC	10

B. The manufacturer shall provide the required number of diffusers and adequately sized air piping to meet the specified oxygen transfer and headloss requirements. If more diffusers are required than specified elsewhere or shown on the drawings, then such diffusers shall be provided. Similar, if larger diameter manifold or drop piping must be furnished to meet the total system pressure drop, then there shall be no adjustments in price for the cost of extra diffusers, larger pipe or fittings.

C. Diffusers Assembly

1. The fixed header air diffusion assembly shall begin with the flanged connection at the downstream side of the wall casting into the tank as shown the Drawings. Parts of the assembly shall be interchangeable.
2. The fixed header diffusion assembly shall be designed to uniformly diffuse air into the tank at a flow rate necessary to maintain homogeneous, completely suspended solids in the tank.

2.3 SYSTEM COMPONENTS

A. Air Headers, Manifolds, and Piping:

1. All piping size, connections, and bracing as recommended by Manufacturer and specified on the drawings.

B. The design, fabrication, and installation of the diffuser equipment shall be such that, upon completion of installation, all diffusers are leveled to 1/4 inch of a common horizontal lane.

C. The entire system shall be designed to allow for expansion and contraction over a temperature range of 50°F to 77°F when installed.

- D. The coarse and fine bubble diffuser aeration equipment shall be designed for easy installation and shall include provisions for level adjustment, rotational adjustment, and thermal expansion.
- E. The location and size of the drop pipe to the diffuser grids are shown on the Drawings. The diffuser equipment shall include, but not be limited to a vertical section of drop pipe, a flexible connection to the drop pipe, an air manifold, air headers, supports, expansion joints, air manifold and header joints, gaskets, bolts, nuts, and washers.
- F. The assembly shall start at the downstream flange of wall casting into the tank. The lower end of the drop pipe shall have a flange for connection to the header. A neoprene O-ring shall be furnished between the flange on the drop pipe and the header flange and be held in place by bolts. The end of the header shall have welded end caps.
- G. Diffuser connectors shall be quick threaded saddle and diffuser mounted top of the PVC headers. Air release from the diffuser into the water shall be at or below this common horizontal plane.
 - 1. The design, fabrication and installation of the entire aeration system shall be such that all diffusers connected to a header can be leveled to within plus or minus 3/8 inc. of a common horizontal plane.
 - 2. There shall be a minimum of two (2) supports per header. All supports shall have a minimum of plus or minus 1 in. of vertical adjustment. Header supports shall be anchored to the floor of the tank with anchor bolts.
 - 3. The lower drop pipe, facing ring and supports shall be PVC SCH 80. Bolts, anchor bolts, washers and follower flanges shall be made from 304 stainless steel. The nuts shall be 303 stainless steel. The pipe, drop pipe shall have a minimum wall thickness of 0.109 in.
 - 4. Gaskets shall be neoprene full face gaskets.
 - 5. Piping, drop leg and header dimensions shall be as shown on the Drawings with dimensions tolerances conforming to ASTM A554-72 and ASTM A530-72.
- H. The drop pipes shall be 304L stainless steel, Schedule 10 to within 4 feet above the basin floor slab or as shown on the Drawings. At that point, the Manufacturer shall provide flex coupling to connect to a stainless steel drop leg which shall extend to the PVC SCH 80 manifold or headers.
- I. Piping section shall be supplied in 20 ft length maximum and connected at site with SS/PVC couplings supplied by Manufacturer.
- J. All PVC welding and gluing shall be done in the factory and NO site welding/gluing involved in the installation of equipment.
- K. All supports are supplied with anchors and accessories.
- L. The air manifold and header piping shall be constructed of PVC Schedule 80 conforming to ASTM D-2241 for diameters up to 8-inch diameter. Both classes of pipe shall have a maximum SDR rating of 26. Pipe and piping grid design shall be capable of withstanding the normal system operating pressure as well as occasional water hammer surges encountered during start up periods. The air manifold shall be perpendicular to the air headers. Air manifolds shall be fabricated with fixed joint connections to each air header. Fabricated manifolds shall not exceed 20 feet in length for shipping. Manifolds shall be designed for long-term exposure to 110°F and short-term (80-hour periods) of 140°F mean-wall temperatures. The ends of the manifolds shall have solvent welded end caps.

- M. All PVC piping shall contain 2% or 2 parts per million average by weight titanium dioxide ultraviolet light inhibitor.
- N. Pipe support for the header and the manifolds shall be provided and installed in accordance with the manufacturer recommendations.
- O. Purge System
 - 1. Diffuser system shall be equipped with a condensate purge to ensure the evacuation of water from the entire submerged aeration piping system.

2.4 DIFFUSERS

- A. Diffusers shall be furnished and installed as shown on the Drawings and as specified in this section:
 - 1. Coarse Bubble Diffusers
 - a. Aerobic Digester No. 1
 - b. Aerobic Digester No. 2
 - c. Aerobic Digester No. 3
 - d. Aerobic Digester No. 4
 - e. Aerobic Digester No. 5
 - f. Sludge Wet Well No. 1
 - g. Sludge Wet Well No. 2
 - 2. Fine Bubble Diffusers:
 - a. The Post Aeration Tank, flows as specified:
 - 1) ADF of 2.0 MGD
 - 2) PHF of 6.0 MGD
 - 3. Number of diffuser zones shall be provided as shown on the Drawings.
- B. The diffusers shall be of proven non-clog design.
- C. The balancing nozzle with a 3/4-inch NPT male pipe connection and removable orifice inserts shall provide the proper headloss to assure uniform distribution through the entire tank aeration system.
- D. The diffuser base shall be molded with high rigidity ABS plastic. The diffuser base shall be of one-piece construction and shall have 3/4" NPT threads for connection to the air header system. The base is hollow centered flared cone with fitted membrane clamped at the bottom.
 - 1. Open bottom diffusers allowing liquid and debris to enter the bottom of the diffuser will not be permitted.

2.5 SUPPORTS

- A. Manifold supports shall include manifold hold-down, guide straps, anchor bolts and supporting structure. Guide straps shall be a minimum 2" wide. Provide supports with a mechanism to provide for plus or minus 2" vertical adjustment for alignment of the manifold in the field. Supports shall be designed to allow for complete removal from the tank (less anchor bolt) to facilitate cleaning and maintenance of tank bottom.
- B. Air Distribution Header Supports:

1. Provide -PVC SCH 80 air distribution header or polypropylene supports of both guide and fixed type to allow for expansion of the system. Supports shall be designed to allow for complete removal from the tank (less anchor bolt) to facilitate cleaning and maintenance of tank bottom.
 2. Guide supports shall consist of a self-limiting hold down and sliding mechanism. Hold down and sliding mechanism shall provide a full circumferential 1.5" wide contoured bearing surface with chamfered leading edges to minimize binding of the air distribution header. Sliding mechanism shall provide minimum resistance to movement of the air distribution header under full buoyant up-lift load. Mechanism shall provide 1/8" clearance around header and be self-limiting if the mechanism is overtightened. Worm gear clamps shall not be utilized for attaching header pipe to supports.
 3. Fixed supports shall consist of a hold down mechanism and self-limiting clamp device. Hold down mechanism and clamp shall provide a full circumferential 1.5" wide contoured bearing surface for the air distribution header. Clamping device shall positively grip the air distribution header when tight and be self-limiting to prevent overstressing the header if the clamp is overtightened. Worm gear clamps shall not be utilized for attaching header pipe to supports.
 4. Provide supports with a mechanism to provide for plus or minus 1.5" vertical adjustment for alignment of the air distribution headers in the field. Adjusting and aligning mechanism shall be infinitely adjustable within its limits to allow precise leveling of the air distribution headers and diffuser assemblies to within plus or minus 1/4" of a common horizontal plane without removing the header from the support.
- C. Attach supports to tank floor with one stainless steel expansion type anchor bolt designed for embedment in 3000 PSI Concrete. Size anchor bolts with pull-out strength, design safety factor of 4 or more.

2.6 HEADER AND MANIFOLD PIPE JOINTS

- A. Provide positive type connection joints bolted or flanged or threaded union type for all submerged header and manifold joints.
- B. Bell and spigot, slip on or expansion type joints shall not be utilized for submerged joints. All joints must be positive locking type.
- C. Threaded union joints shall consist of a spigot section solvent welded to one end of a distribution header, a threaded socket section solvent welded to the mating distribution header, an "O" ring gasket and a threaded screw on retainer ring. Solvent welding shall be done in the factory. Flanged joints shall be of follower type with stainless steel hardware and shall have standard 125 lb. drilling.

2.7 SPARE PARTS

- A. Spare parts shall be shipped with the aeration equipment and stored by the Contractor until turned over to the Owner during project closeout.
- B. Spare parts used during startup and prior to acceptance of the equipment shall be replaced by the Contractor at no additional cost to the Owner.

- C. The following spare parts shall be furnished and shall be suitably marked and boxed (protected from UV light) for shipment and storage.
- D. Disc Diffusers
 - 1. Five (5) 9" disc fine bubble diffusers
 - 2. Eleven (11) coarse bubble diffusers
 - 3. Ten (10) 4" support
 - 4. Five (5) 4" couplings

PART 3 - EXECUTION

3.1 PREPARATION FOR SHIPMENT

- A. The coarse and fine bubble diffuser aeration equipment shall be packaged and shipped by the Manufacturer ready for unloading, storage, and installation by the Contractor. The Contractor shall provide a suitable storage space for the aeration equipment.

3.2 OPERATION AND MAINTENANCE MANUALS

- A. Prior to or with the delivery of equipment, the manufacturer shall provide copies of an operation and maintenance manual including storage, installation, start-up, operating and maintenance instructions, and complete parts list and recommended spare parts list. The O & M Manuals shall be in compliance with the General Requirements.

3.3 INSTALLATION

- A. Contractor shall verify existing conditions of piping, size and elevations before starting work.
- B. Contractor shall install air diffusers and entire system per manufacturer instructions, as indicated on the Drawings and specified herein.
- C. Provide anchorage system as recommended by manufacturer and anchor unit securely in place.
- D. After two weeks of continuous operation, the aeration system shall be taken out of service and dewatered by the Contractor. While the tank is out of service, the Contractor shall inspect each diffuser to determine whether it has rotated from its original position. Diffusers which have rotated shall be repositioned and measures shall be taken to prevent recurrence of the problem. Such measures shall not affect the removability of the diffusers. If rotation problems are observed, the tanks shall be operated for another two (2) weeks and again dewatered and inspected by the Contractor. The sequence shall be repeated until rotation of the diffusers is no longer encountered.
- E. If required, Contractor shall make any changes, at his own expense, to the installation that may be necessary to assure satisfactory operation. Contractor shall be held liable for changes needed in the installation.
- F. Touch-up minor damaged surfaces caused during installation. Replace damaged components as directed by the Owner.

3.4 INSPECTION, STARTUP, AND TESTING

- A. The manufacturer of the equipment shall provide a representative to check the installation, make final adjustments, supervise the initial startup of each assembly, and prepare a written report thereof for the Owner.
- B. Manufacturer's certificate of satisfactory installation is required for work under this Section.
- C. The representative shall also instruct the Owner's personnel in the operation and maintenance of the equipment.
- D. Manufacturer's Field Service: After installation of all equipment has been completed, the manufacturer shall provide two (2) trips for a total of four (4) - 8-hour days to verify the installation, conduct performance tests and on-site training and any additional trips to insure satisfactory operation of equipment.

3.5 PERFORMANCE TESTS

- A. Test: File a report on results.
- B. Inspection: File a report on installation.
- C. Manufacturer's Field Service:
 - 1. A qualified factory representative shall inspect, test, installed equipment to be sure it meets manufacturer's requirements.
 - 2. The factory representative shall revisit the job site as often and as necessary until all problems are corrected and the installation is entirely satisfactory to the owner or owner's representative.
- D. Field Tests:
 - 1. Clean Water Functional Test
 - a. After installation of the coarse and fine bubble diffuser aeration equipment is complete, witness functional testing conducted by the Contractor to check for leaks, uniformity or air release, and verification of level installation. Functional testing shall be performed with clean water at a depth over the diffuser as recommended by the aeration system Manufacturer. Any leaks in the headers, diffuser, pipes, or any part of the system shall be repaired by the Contractor. The test shall be repeated until the installation is void of air leaks
 - 2. Pressure Tests
 - a. A pressure test shall be performed on the air diffuser system(s). The tank(s) shall be filled to the normal operating depth. The operating pressure shall be recorded at minimum, average and maximum conditions. The pressure shall not exceed the values listed in the Schedule - A.
 - 3. Adjust unit mechanism to achieve specified requirements.

3.6 DEMONSTRATION AND INSTRUCTIONS

- A. Demonstrate and instruct Owner, Owner's representative or operators on unit operation. A qualified factory representative shall instruct plant personnel on operation, care and

maintenance of the equipment. The factory representative shall revisit the job site as often but no less than one eight-hour day. Describe unit limitations.

- B. Any revisions during startup and testing which require revisions to the maintenance or operating instructions shall be made in each of the final copies prior to final payment being make to the Contractor.

END OF SECTION 467321

SECTION 467331 – DEWATERING MULTI-DISK SCREW PRESS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.
- B. Related Section:
 - 1. Section 030000 – Concrete Work
 - 2. Section 055800 – Metal Fabrications
 - 3. Section 099700 – Special Coatings
 - 4. Division 26 – Electrical
 - 5. Section 461211 – Shaftless Conveyor
 - 6. Section 463333 – Polymer System
- C. This section contains references to the following documents:
 - 1. American National Standards Institute (ANSI)
 - 2. American Society of Testing and Materials (ASTM)
 - 3. American Iron and Steel Institute (AISI)
 - 4. American Welding Society (AWS)
 - 5. American Institute of Steel Construction (AISC)
 - 6. American Bearing Manufacturers Association (ABMA)
 - 7. American Gear Manufacturers Association (AGMA)
 - 8. National Electrical Manufacturers Association (NEMA)
 - 9. Underwriters Laboratory (UL).
 - 10. National Electrical Code (NEC)

1.2 DESCRIPTION OF WORK

- A. CONTRACTOR shall provide all labor, materials, equipment and incidentals as specified and required to furnish and install a Multi Disc Screw Press for sludge dewatering and any associated equipment required to construct a system capable of dewatering feed sludge and producing a dry and solid cake.
- B. This section shall include furnishing One (1) Multi Disc Screw Press equipped at minimum with three (3) dewatering drums, together with associated sludge conditioning tank, control panel, polymer system, flowmeter, dewatered cake conveyors, and access platform as specified in the Contract Documents and as required to meet the specified performance requirements and to provide a full and properly functioning sludge dewatering system.
- C. Review installation procedures under other Sections and coordinate the installation of items that may need to be installed with the Multi Disc Screw Press.
- D. All equipment furnished under this section shall be the responsibility of a single Manufacturer to fabricate or procure, integrate, factory test, and deliver to the project site. It shall be the responsibility of the Manufacturer to coordinate all details and components required for a properly functioning system.

- E. The Dewatering Press unit provided must include capacity to add an additional dewatering drum and increase the throughput capacity of the unit by 30% with no structural modifications. If a unit is offered without this capacity, a second identical unit must be provided under this section. A single larger unit is not acceptable as the additional dewatering drum provides redundancy in addition to the extra capacity.
- F. All welding shall conform with the American Welding Society Structural Welding Code.
- G. All construction shall allow easy access and visual inspection of all internal components.
- H. All electrical work, motors and drives shall comply with all relevant NEMA standards.

1.3 SYSTEM DESCRIPTION

- A. The sludge dewatering system shall consist of the Dewatering Screw press sized to dewater aerobically digested sludge with the following parameters:
 - 1. Type of Influent Solids: Aerobically Digested Waste Activated Sludge
 - 2. Influent Dry Solids Concentration: 2%
 - 3. Hydraulic Capacity: 120 gpm
 - 4. Solids Loading Capacity: 1000 lbs/hr
- B. The Dewatering Screw Press shall be a complete, prefabricated sludge dewatering system, as described herein and shown on the Drawings, consisting of the following:
 - 1. Flocculation and dosing chamber used for flocculation/mixing of the polymer and influent sludge. This tank shall be equipped with a sludge inlet, drainage outlet, polymer (flocculant) inlet, an electric agitator and mixer. The feed tubes connecting mixing tank with dewatering drums.
 - 2. Three (3) dewatering drums run by gearmotors equipped with individual rinsing water system with nozzles. Each dewatering drum shall have individual fixing elements and can be removed separately while other screws are in operation. An additional section for a fourth dewatering drum shall be left empty for future expanding needs.
 - 3. The filtrate collection tray shall be provided with flanges for filtrate removal. Side walls of the filtrate collection tray are an integral part of the frame-base.
 - 4. A self-contained electrical and control panels including control for ancillary equipment such as feed pumps and solids conveyor.
- C. The dewatering system shall integrate all appurtenances necessary for a complete, functional dewatering system operation, including but not limited to the following:
 - a. Liquid Polymer Blending System
 - b. Sludge Feed Pumps
 - c. Inline Grinders
 - d. Dewatering Conveyors
 - e. Flowmeter

1.4 PERFORMANCE TESTING

- A. Performance testing must demonstrate that performance of the dewatering equipment can simultaneously achieve:

1. Sludge processing capacity of 1000 dry pounds per hour, 330 dry pounds per hour per dewatering drum, and be capable of dewatering liquid 100% aerobically digested waste activated sludge with solids concentration ranging 2-4 percent to a cake with average solids concentration above 17-18 percent. This design loading must be achieved at or below the maximum drum rotation speed specified below.
2. Minimum solids capture rate shall be 98% at the rated capacity of the Multi-Disc Screw Press.
3. Stated average performance criteria shall be obtained with a maximum cationic emulsion polymer, with active polymer concentration $\geq 39\%$, dosage of 2-3 gallons per dry ton of solids (16-20 lbs of polymer/dry ton).
4. Flushing water shall be used only for rinsing of outer area of the dewatering drum, but not for cleaning of filtration gapes.
5. If a different configuration of drums is provided, the total sludge processing capacity, solids capture and polymer dose shall be met without exceeding the specified maximum drum speed.

1.5 QUALITY ASSURANCE

- A. All equipment and components shall be furnished as complete standard type assemblies in accordance with the standards of the industry.
- B. All equipment furnished under this section shall be of a single manufacturer who has been regularly engaged in the design and manufacture of the specified equipment.
- C. To ensure unity of responsibility, the Screw Press, supporting frames, polymer mixing and feeding blend unit, conveyors, and control systems shall be furnished and coordinated by a single supplier. The Contractor shall assume full responsibility for the satisfactory installation and operation of the entire dewatering system package.
- D. The Supplier shall have at least ten (10) full-scale systems utilizing the exact technology at the same scale size proposed for this project operating successfully for at least three (3) years in North America at municipal wastewater treatment plants that were furnished under the manufacturer's own name.
- E. Prior to shipment, the Dewatering Screw Press and control panel shall be factory tested at the place of assembly. Factory test each pre-assembled, pre-wired, Multi-Disc Dewatering Screw Press and its associated control panel to be supplied to the job site. Prior to shipment, verify through a one-hour continuous operating test that the Multi-Disc Dewatering Screw Press and associated equipment operate smoothly, noiselessly, vibration free, and without overheating of any bearing or motor.
- F. The owner/engineer shall, at their option, be permitted to witness the factory quality control test at the manufacturer's facility. The manufacturer shall give the owner/engineer a minimum of one (1) week notice prior to testing.
- G. The equipment furnished shall be fabricated, assembled, installed, and placed in proper operation condition in full conformity with approved drawings, specifications, engineering data, and/or recommendations furnished by the equipment manufacturer. The equipment manufacturer shall, in addition to the Contractor, assume the responsibility for proper installation and functioning of the equipment.

- H. In addition to requirements of these specifications, comply with manufacturer's instructions and recommendations for work. All equipment shall perform as specified and accessories shall be provided as required for satisfactory operation.

1.6 SUBMITTALS

- A. Submit manufacturer's technical data and application instructions per Section 013323.
- B. Product Data: Submit manufacturer's technical data and application instructions.
- C. Shop Drawings: The Contractor shall submit complete shop drawings of all equipment furnished for this project as covered by these specifications. All shop drawings shall clearly identify the specific equipment and material being supplied, the quantity being supplied, and all accessories, dimensions, descriptions, dimensional/orientation layout drawings, mounting and connection details, electrical control diagrams, wiring schematics and any other information required of the Engineer/Owner to determine compliance with the plans and specifications. The submittal as a minimum shall include the above data drawings and other related materials. The shop drawings shall be reviewed by the Contractor for completeness and compliance with the project and so acknowledge prior to the review by the Engineer.
- D. Shop Drawings: Submit for review the following:
 - 1. Dimensional drawings depicting all mechanical and electrical equipment dimensions and required overhead clearances.
 - 2. Equipment layout, principal dimensions with related verifications required for installation including anchorage location.
 - 3. Details on connectors for solids discharge chutes.
 - 4. Equipment weight
 - 5. Electrical control drawings
 - 6. Drive motor data
 - 7. A list of recommended Spare Parts including any Special Tools required for routine maintenance of the equipment.
 - 8. Certified copies of performance shop test data and reports shall be supplied for approval before shipment from the factory.
- E. Operation and Maintenance (O & M) manuals shall describe the theory of dewatering system, start-up, optimization and maintenance operations for the equipment furnished and installed under this Section. The final O & M manuals shall be provided in digital format after equipment start-up in the close-out submittal process. The O & M manuals shall meet the requirements of Sections 01060 and 01097, including the following additional information:
 - 1. As-Build Drawings of the Multi Disc Screw Press.
 - 2. Electrical diagrams
 - 3. Controls and Accessories
 - 4. Explanation of operating safety considerations
 - 5. Repair Parts and maintenance materials
 - 6. Troubleshooting data
 - 7. Repair data
- F. Warranty: The Equipment Manufacturer shall submit a warranty certificate for review. The date of the warranty begins after commissioning and operational demonstration and will be determined in the field by the Owner's Engineer.

1.7 WARRANTY

- A. The manufacturer shall warrant, in writing, that all equipment supplied by them shall be free from defects in material and workmanship, for a period of twelve (12) months from the date of startup, not to exceed eighteen (18) months from the date of delivery, unless noted otherwise within the specifications.
- B. Any defects found within the warranty period shall be replaced if damaged or defective in the normal use of the equipment at no cost to the Owner.

1.8 DELIVERY, STORAGE AND HANDLING

- A. Comply with Section 016600, Product Handling and Protection.
- B. Equipment shall be shipped and delivered fully assembled, except where partial disassembly is required in order to conform to transportation regulations or for the protection of components.
- C. Handling, delivery, and storage of the equipment shall be in accordance with the Manufacturer's recommendations. No extra cost shall be charged the Owner for the handling, delivery, or storage of the equipment.
- D. Contractor shall be responsible for unloading and shall have equipment on-site at the time of delivery permitting proper hoisting of the equipment.
- E. Acceptance at Site:
 - 1. Inspect all equipment and materials against reviewed Shop Drawings at time of delivery.
 - 2. Equipment and materials damaged or not meeting the requirements of the reviewed Shop Drawings shall be immediately returned for replacement or repair.
 - 3. The Contractor shall notify the Manufacturer on any damages to equipment within 5 days to effect proper remedial action. Failure to notify the Manufacturer of damage to equipment prior to unloading shall void all warranties pertaining to subject equipment.
- F. Storage and Protection: Store all equipment and materials in a dry, covered, ventilated location and protect from harm according to the manufacturer's instructions. Carefully prepare for storage and label all equipment and materials after they have been inspected.

1.9 SEQUENCING

- A. Comply with Section 011100, Summary of Work.
- B. The Contractor shall take special note that the City of Sunbury WWTP must remain in operation at all times unless outages are approved by the Owner.

1.10 SPARE PARTS

- A. Furnish the following spare parts:
 - 1. Spray wash system solenoid valve.

2.1 MANUFACTURERS

- A. Acceptable Manufacturers: Subject to compliance with specified requirements, provide equipment supplied by one of the following manufacturer:
 - 1. Esmil Group, Multi-Disc Screw Press
 - 2. Process Wastewater Technologies, Volute Dewatering Press, PWTech.
 - 3. Or Engineer approved equal.
- B. The sludge dewatering process, electrical, controls and structural design has been based around Esmil Group, Multi-Disc Screw Press. Other named or approved equals may differ with respect to the structure, electrical power, or controls.

2.2 EQUIPMENT DESCRIPTION

- A. General
 - 1. The Screw Press shall be designed to adequately condition and dewater the sludge such that a dewatered sludge cake is produced that easily discharges from the dewatering drum, without binding or plugging.
 - 2. System shall be designed to operate in the environment for which it is intended, continuously or intermittently on demand, and shall perform the required dewatering operations without spillage of water or sludge beyond the nominal machine envelope.
 - 3. The system shall operate without the need for operator attention other than periodic inspection and chemical replenishment.
 - 4. The Dewatering press shall allow 30% capacity increase without any structural modifications by adding drum number four (4) to the installed dewatering press frame. Adding a 4th drum shall not require any type of drum frame structural modification or drum disassembling/assembling onsite. The additional drum shall be equipped with a drum cover.
 - 5. Manufacturer shall provide a Flowmeter to control influent sludge flow to the screw press, installed as shown on the Drawing. The Flowmeter shall be the electro-magnetic type, by Endress Promag W400, or equal. The flowmeter shall have 4-inch flanges, ANSI 150 lbs, and NEMA 4X enclosure.
- B. The Dewatering Screw Press shall be a complete prefabricated system as described herein and shown on the Drawings, consisting of the following:
 - 1. Flocculation and dosing Chamber:
 - a. Installed on the separated frame.
 - b. Tank shall be equipped with adjustable thread coupling located inside the chamber.
 - c. Sludge conditioning system consisting of flocculation chamber with a mixer (agitator) with electric drive-motor which allows efficient mixing of polymer solution with initial sludge. Mixer is equipped with two adjustable blades to perform proper flocculation process.
 - d. Flocculation and dosing chamber frame is equipped on both sides with eyelets for transportation and holes for anchoring to the concrete base.
 - e. The flocculation and dosing chamber shall be equipped with steps to facilitate operator access to the top of the tank for effective supervision of the flocculation process.
 - f. The flocculation and dosing chamber shall be equipped with a junction box to enable the connection to the main screw press control panel.

2. Three (3) dewatering drums with drive-motors including individual rinsing water system with nozzles. Each dewatering drum shall have individual fixing elements and can be removed separately while other screws are in operation.
 - a. The dewatering drum consists of a variable flight pitch screw located within a support frame of alternating fixed and moving discs. Fixed discs are equipped with spacers that hold the fixed discs apart and provide a gap for moving discs between them.
 - b. The feed tubes connecting mixing tank with dewatering drums.
 - c. A spring-loaded dam plate at the end of the drum sets the gap from where the cake exits, providing the back pressure that forces final sludge dewatering.
 - d. An additional section for an installation of the fourth dewatering drum shall be provided, with the grating designed for a combined load of 50 pounds per square foot, and with the rinsing water valve already in place for the future expansion.
3. Machine frame structure for the dewatering drums includes filtrate collection tray and outlet flanges. Frame is equipped on both sides with eyelets for transportation and holes for anchoring to the concrete base.
4. The flocculated sludge is fed into the dewatering drum by self-flowing through feeding tubes. Filtrate seeps between the moving and fixed drum disks and drains out into the filtrate tray below the dewatering drum. Next the filtrate is discharged from the drums through a filtrate discharge pipe and returned to the plant.
5. As the sludge moves through the drum, the water is removed through the gaps between the movable and fixed disks. In the thickening zone, water is removed from sludge by the gravity and pressure of the screw flights. In the dewatering area, sludge is compressed due to the reduction of the space between the screw flights and conical shape of the shaft.
6. The final compression of sludge occurs at the end of the dewatering area by an adjustable dam plate mounted on the outlet end of the screw. Through a gap between the plate and the drum end, the dewatered sludge is squeezed out of the drum to a container.
7. A self-contained electrical and control panel including control and monitoring of ancillary equipment such as main equipment: sludge feed pump, polymer preparation and feed equipment, and dewatered sludge cake removal equipment.

2.3 MATERIALS OF CONSTRUCTION

- A. All materials utilized in the construction of the sludge dewatering equipment shall be entirely suitable in every respect for the service required. All metals in contact with polyelectrolyte or sludge, and all other metal components other than those specified below in Table 1 shall be stainless steel, type 304 or 316.
- B. No carbon steel shall be used for any part of the screw press.
- C. The following table indicates the materials and coatings that shall be provided for The Screw Press and related components unless specified otherwise herein:
 1. Flocculation and dosing chamber and Support Frame: Type AISI 304 Stainless steel
 2. Rinsing Water Spray Pipes: Type AISI 304 Stainless steel, plastic
 3. Technological pipes: Type AISI 304 Stainless steel, plastic
 4. Dewatering Drums: Type AISI 304 Stainless steel
 5. Dewatering Drum Screw: Type AISI 304 Stainless steel with FREA-metal blade edge
 6. Gear Motors: Cast Iron
 7. Gear Motor Coating: Acrylic paint
 8. Spray Nozzles: Plastic

9. Dewatering drums covers: AISI 316L, Polycarbonate
10. Electrical Enclosure: Carbon Steel with acrylic paint or AISI 304 Stainless Steel
11. Electrical Wiring Housing: Non-metallic flexible liquid-tight conduit and fittings
12. Valve, Wetted Sections: Stainless Steel or Brass, EPDM Seating

2.4 STRUCTURAL COMPONENTS

- A. The structural support frame shall be fabricated of type 304 stainless steel. It shall be a rigid structure, adequately braced to withstand intended loads without excessive vibration or deflection.
- B. The framework shall be of welded and/or bolted construction. The structure shall be designed for installation on a prepared concrete foundation and secured with anchor bolts.

2.5 DEWATERING DRUMS

- A. The dewatering drums shall be constructed of ASTM type 304 Stainless Steel. All circular components shall be laser cut to ensure maximum evenness of wear and operating life. The dewatering drum consists of a screw shaft rotating with a variable speed in the cylindrical body. The body consists of a support structure and series of alternating fixed and movable disks with gaps between them. The width of the gap decreases towards the discharge zone, from 0.02" in the thickening area up to 0.011" in the dewatering area and up to 0.0059" at the end of the drum. Nominal drum size shall be 18-inch.
- B. The dewatering drums must have a minimum internal volume of 45 cubic feet. The maximum operational speed of the dewatering drums must not exceed 2.5 RPM at the design loading.
- C. Screw flights side shall be protected by welded hard metal strips "Frea-Metal" with thickness of not less than 0.05 inches. Vickers hardness of the metal strips shall be not less than 600 Hv or Brinell Hardens of 534 HB.
- D. Screws shaft shall have conical form with diameter increasing from initial sludge inlet zone to cake discharge zone for increasing DS content in the dewatered sludge.
- E. Assembly shall be undertaken in such a way that all fixed discs shall be concentric and parallel. Fixed and movable discs thickness shall not be less than 0.12 in. All fixed discs shall be supported by a common support frame and be equally spaced apart for each section of the dewatering drum. Spacers must be fixed into fixed discs by thread connection. Any separate spacers are not allowed. Fixed and movable discs shall be made of AISI 304 Stainless Steel, using of plastic discs is not allowed. Movable discs shall be changeable with life period of not less than 15,000 operation hours.
- F. The dewatering drum shall be installed in horizontal position with two mounting points to unit's frame - at the initial sludge inlet zone and at the cake discharge zone. Intermediate fixation points along the drum are not allowed.
- G. Each Dewatering Drum shall be equipped with individual spray bar. Each spray bar shall consist of a spray pipe fitted with spray nozzles, located above the dewatering drum. The spray pipe and spray nozzle assembly shall be readily removable. Nozzle spacing and spray pattern shall be such that the sprays from adjacent nozzles overlap one another on the dewatering drum surface. The sprays shall operate periodically and shall partly remove solids built up externally on the drum

such that over time no significant buildup of solids occurs on the drum. Each spray bar must be equipped by solenoid valve.

1. Nominal rinsing water consumption: 29 gpm
2. Nominal rinsing water pressure: 30-60 psi
3. Typical total consumption: 87 gph

H. Each Dewatering Drum shall have a drive motor:

1. The Dewatering Drum drive motor shall be a one-piece gear-motor.
2. Gear-motors shall be hollow shaft design, designed to drive the dewatering drum screws with no additional couplings or joints. Motors shall be filled with grease on assembly and sealed for life. Screw rotational speed shall be obtained through a reduction gear. Input power to the dewatering drum drive shall be supplied through an A.C. variable frequency drive unit.
3. Drive Motor Data:
 - a. Maximum Horsepower: 3 Hp
 - b. Power Requirements: 460 VAC, 3-phase, 60 Hz
 - c. No load motor speed: 1765 RPM, VFD
 - d. Gear Reduction: 435.50:1
 - e. Max output shaft speed: 4.1 RPM @ 60Hz
 - f. Insulation Class: NEMA 4
 - g. Enclosure: TEFC
 - h. Enclosure material: Die Cast Iron

2.6 FLOCCULATION CHAMBER

- A. The Screw Press shall have a mixing system which consists of flocculation chamber equipped by agitator with drive motor. Chamber sizing and design shall ensure adequate residence times and mixing conditions to ensure complete flocculation and satisfactory dewatering performance. Chamber design shall minimize the possibility of any short circuiting of flow.
- B. Design and manufacture of the chamber shall ensure no leakage of fluids under normal working conditions.
- C. The flocculation chamber shall be manufactured in type AISI 304 Stainless Steel.
- D. The flocculation chamber shall be equipped with maximum level sensor and pressure sensor.
- E. Each Agitator shall have a drive motor:
 1. The flocculation chamber drive motor shall be a one-piece gear-motor.
 2. Gear-motors shall be hollow shaft design, designed to drive the agitator with no additional couplings or joints. Motors shall be filled with grease on assembly and sealed for life. Screw rotational speed shall be obtained through a hypoid reduction gear. Input power to the agitator drive shall be supplied through an A.C. variable frequency drive unit.
 3. Flocculation chamber drive motor data:
 - a. Maximum Horsepower: 3 Hp
 - b. Power Requirements: 460 VAC, 3-phase, 60 Hz
 - c. No load motor speed: 1765 RPM, VFD
 - d. Gear Reduction: 93.5:1
 - e. Output shaft speed: 19 RPM @ 60Hz

- f. Insulation Class: NEMA 4
- g. Enclosure: TEFC
- h. Enclosure material: Die Cast Iron

2.7 CONTROLS

- A. The Screw Press shall have an integrated electrical control system that shall allow for safe, simple, and automated operation of the unit. The electrical control system shall have statuses for unit in operation, and unit alarms to an external PLC (plant SCADA system). External SCADA system connection shall be over Ethernet and allow to monitor status and alarms for all system components available at local control system as minimum.
- B. Control Panel Features:
 1. The contractor shall furnish, install and commission a Remote PLC Panel (MCP-1025C), refer to electrical drawings for panel location. For exterior installation locations see Specification 409601. For interior installation locations see Specification 409602.
 2. The contractor shall furnish, install and commission a separate Motor Control Panel (MCP-1025B) for VFDs/ motor starters as outlined. Refer to electrical drawings for panel location and mounting requirements. The enclosure shall be NEMA 4X SS for exterior locations and NEMA 4 for interior locations. The motor control panel shall include but not be limited to: VFDs / motor starters as outlined, power supply, main 3 phase disconnect C/W front door handle, breakers, fuses, line reactors, terminals, etc. Provide adequate panel heating/cooling to meet panel interior components environmental requirements. All VFDs shall communicate with Remote PLC Panel via Ethernet. Each VFD shall have a front door mounted HIM module. Each motor (VFD/Motor Starters) shall have a front door mounted HOA with green run indicator light and red fault indicator light. VFD manufacturer shall be A-B PowerFlex or approved equivalent.
 3. Variable frequency drives (VFD) shall be provided for the dewatering drums drive motor, and mixer in flocculation chamber.
 4. Control Panel shall be UL listed.
 5. Enclosures: Control panel enclosures shall be free-standing, wall mounted, and it shall be located in the Electrical Room. The Control Panel is fabricated of AISI 304 Stainless Steel and shall be suitable for NEMA 4X service. Enclosure shall be a maximum of 12-inch deep.
 6. The control panel shall accept a 480volt, 60 hertz, 3-phase AC power input.
 7. Short circuit and overcurrent protection for system components shall be accomplished utilizing fuses. Individual thermal overload protection shall be provided for each motor.
 8. Control Panel shall be capable of receiving and processing all input and output signals "To" & "From" the equipment specified in this Section:
 - a. Table below includes but is not limited to a summary of additional I/O points to be directly monitored or controlled by the Multi-Disc Screw Press.

Signal Description	Signal Type	I/O Type
Sludge Pump - Start/Stop Command	Control	N/O Output
External Sludge Pump – Run Status	Status	DI
Sludge Pump - Fault	Status	DI
Sludge Pump - VFD Speed Control	Control	AO
Sludge Pump – Dry Run – Stator Over Temp		
Grinder - Start/Stop Command	Control	N/O Output
Grinder – Run Status	Status	DI

Grinder - Fault	Status	DI
Conveyor 1 - Start/Stop Command	Control	N/O Output
Conveyor 1 - Run Status	Status	DI
Conveyor 1 - Fault Alarm	Alarm	DI
Conveyor 2 - Start/Stop Command	Control	N/O Output
Conveyor 2 - Run Status	Status	DI
Conveyor 2 - Fault Alarm	Alarm	DI
Polymer System - Start/Stop Command	Control	N/O Output
Polymer System Concentrate Pump – Run Status	Status	DI
Polymer System – Remote Status	Status	DI
Polymer System Water Low Flow – Fault Alarm	Alarm	DI
Polymer System – Speed Control	Control	AO
Multi Disc Screw Press System General Alarm to Plant SCADA System	Alarm	Ethernet
Flow Meter	Control	AI

C. External Enclosure Features:

1. The external door of the control panel shall have the following switches and indicators:
 - a. Main Isolating Switch (Circuit Breaker).
 - b. An emergency stop button which shall be a mushroom head style pushbutton that when depressed shall immediately de-energize all moving equipment in the system.
2. Within a windowed enclosure mounted on the panel door:
 - a. HMI Touch Screen.
 - 1) The HMI for the system shall be a WEINTEK with minimum 15-inch LCD screen and fully compatible with the PLC. The unit shall provide a graphics interface and utilize menu driven screens to allow dewatering system control, status monitoring, and alarm handling; and provide both fully automatic control and override manual control features.
 - 2) The HMI shall provide access to all status and control functions for operations personnel with password access to limit change options dependent on authority.
 - 3) The HMI shall also provide access to diagnostic information, e.g. I/O status, and all PID and control functions for the commissioning engineer to allow changes to be made with appropriate password without the need for a programming terminal.
 - b. An H-O-A system switch to switch the system from HAND (Manual) to OFF to AUTO modes.
 - 1) In Hand mode the HMI shall include manual (local) control of all motors controlled by the Press Control System.
 - c. Power on Light (green).
 - d. An Operating Light for when the unit is in operation (green).
3. Provide a general Alarm Light and Horn- a flashing (red) light located on the top of the panel.

2.8 PROGRAMMABLE LOGIC CONTROLLER (PLC)

- A. The Screw Press shall be provided with an Allen Bradley PLC, installed, wired, and programmed to perform the listed functions. The PLC shall be a standard unit with no specialist hardware or firmware modifications. Full application software will be generated by the Screw Press manufacturer to operate the dewatering system using the PLC manufacturer's proprietary software package.
1. Operational Control:
 - a. Control of all components of the dewatering system including the ability to set times, operation and operating speeds or capacities for the sludge dewatering press feed pump, discharge sludge cake conveyors, dewatering drums, mixers, polymer blending and feed system and wash-down sprays.
 2. System Tuning:
 - a. PLC shall allow suitably qualified operators to adjust operating parameters such as delay timers for fault alarms and system calibration constants.
 3. Monitoring Operation:
 - a. PLC shall allow the operator to inspect the operation of all the components including indicators such as output speed or capacity, elapsed operating times, and any faults present.
 - b. Operator shall be able to view approximated readouts of all operational speeds and flowrates relevant to the operation of the system.
 4. Manual Operation of Components:
 - a. Operator shall be able to operate manually each item of equipment from the PLC/HMI interface for inspection and maintenance reasons.
 5. Time Clocks:
 - a. Operator shall be able to set the unit to operate at specific time or on specific days with no operators present.
 6. The PLC shall include an Ethernet port for communications and for import and export of all dewatering system equipment data from/to the plant SCADA system.
 7. The PLC shall be capable of monitoring, recording, and outputting all input and output status parameters noted herein to the HMI and the plant SCADA system.
- B. The PLC shall be capable of monitoring, recording, and outputting all alarm conditions to the plant SCADA system.

2.9 ELECTRICAL HARDWARE

- A. Power wiring shall be 460VAC, type SIS insulation stranded copper and shall be sized for the required load, 12AWG minimum.
- B. Control wiring shall be 24VDC, type SIS insulation stranded copper and shall be sized for the required load, 18AWG minimum.
- C. Main three-pole switch disconnectors GA series Lovato Electric. Circuit breakers shall be iC60N C series Schneider Electric or equal.
- D. Motor starters shall be full voltage, non-reversing, IEC style across-the-line units. Coils shall be 24VDC. Schneider Electric type or equivalent.

- E. Selector switches shall be heavy duty, corrosion resistant units rated for NEMA 4X service. Contact blocks shall be rated for 10A continuous service. Selector switches shall be Harmony XB4 series Schneider Electric or equal.
- F. Pilot lights shall be heavy duty, corrosion resistant units rated for NEMA 4X service. Units shall be 24VDC full voltage incandescent type. Pilot lights shall be Harmony XB7 series Schneider Electric or equal.
- G. Terminal blocks shall be high density, solderless box lug style, with 600-volt rating. Terminal blocks shall be Wago, Wieland type or equal.
- H. Control relays shall be general purpose type with a 6A contact rating, miniature square base and internal on status pilot light. Relays shall be Schneider Electric Type RXM4 Series or equal.
- I. Programmable Logic Controller (PLC) shall be Allen Bradley.
- J. Variable Frequency Drives (VFD) shall be UL listed and shall be manufactured by Allen Bradley.
- K. Power and control devices for the screw conveyor trough heating and insulation per Section 461211.

2.10 FUNCTIONAL DESCRIPTION

- A. The control panel shall undertake the following operations:
 1. Auto-Manual Operation: The Screw Press system shall be able to be set to either Auto, Manual or Off on the control panel.
 - a. When set to manual, all items must be switched on and off at the control panel by the switches on the HMI unit.
 - b. When set to off, no items shall work whether switched on or off either at the control panel or anywhere else.
 - c. When set to auto, all items of equipment shall be turned on into work as per the following descriptions:
 - 1) Under this mode of operation, the screw press will run constantly and will shut itself down in the event of any malfunctions detected by the control system. The screw press should always be run in automatic mode.
 - 2) Turn automatic mode on by switching the three-position selector switch H-O-A to automatic position and pressing automatic mode button on the touch panel.
 - 3) A mixer drive in flocculation chamber switches "On" in automatic mode.
 - 4) Influent sludge feed pump and polymer feeder switch on after the predetermined delay time counting from the moment of turning automatic mode on.
 - 5) The screws' drives are switched on when the preset sludge level in the flocculation chamber is reached.
 - 6) Also, after screws' drives are switched on and subsequently operated in the automatic mode, rinsing valves will be activated periodically, according to the predefined stop and start intervals. If there is more than one valve, only one valve opens at a time to reduce instantaneous water requirement.

- B. The control panel shall provide signals to allow for all input and output parameters and alarms to be taken directly from the Screw Press control panel to the plant SCADA system. Provide a list of addresses for all parameters and alarms. The Plant SCADA system will not monitor the system parameters as a part of this scope but shall provide the capability for future use.

PART 3 - EXECUTION

3.1 DELIVERY

- A. All equipment shall be shipped and delivered fully assembled, except where partial disassembly is required in order to conform to transportation regulations or for the protection of components.

3.2 INSTALLATION

- A. Equipment shall be installed in accordance with the Manufacturer's recommendations to provide a complete installation.
- B. All lubrication required for initial operation shall be furnished and applied in accordance with the Manufacturer's recommendations.
- C. It is the intent of this Contract that the final installation shall be complete in all respects and the Contractor shall be responsible for minor details and any necessary special construction not specifically included in the drawings or specifications.
- D. Equipment shall be installed in strict conformance with the manufacturer's installation instructions, as submitted with Shop Drawings, Operation and Maintenance Manuals and/or any pre-installation checklists.
- E. Anchor bolts size shall be per manufacturer recommendation. Anchors, anchor bolts, nuts and washers shall be 316 stainless steel and furnished for each item of equipment by the Contractor.
 - 1. Anchor bolt template drawings shall be included in the submittal to permit verification of the location structural elements, new or existing in the concrete.
 - 2. Equipment manufacturer shall specify ample size and strength required to securely anchor each item of equipment. Anchor bolt template drawings shall be included in the submittal to permit verification of the location structural elements, new or existing in the concrete.
 - 3. Equipment shall be placed on the foundations, leveled, shimmed, bolted down, and grouted with a non-shrinking grout.

3.3 ELECTRICAL CONNECTIONS AND CONTROLS

- A. Wiring and conduits for electrical power, control and instrumentation will be provided as shown in the Drawings and under Division 26 – Electrical and Division 40 – Process Integration Specifications.

3.4 TESTING

- A. After completion of the installation, the equipment shall be tested by the Contractor in the presence of the Engineer under actual operating conditions. The test shall be conducted under

the supervision of the manufacturer's technical representative and shall demonstrate that the equipment is fully operational by picking up and depositing materials into specified containment.

- B. Field certification shall include inspection of the following:
 - 1. Verify equipment is properly aligned and anchored per the installation instruction and drawings. Assure all piping and valves are installed and properly connected, and the dewatering equipment is unobstructed with required clearances maintained.
 - 2. Assure controls and instrumentation work in all modes.
 - 3. Check equipment for proper operation as well as completion of the Start-Up requirements in the installation guide.
- C. Performance Testing.

3.5 EQUIPMENT MANUFACTURER'S SERVICE REPRESENTATIVE

- A. After completion of the installation, the equipment shall be tested by the Contractor in the presence of the Engineer under actual operating conditions. The test shall be conducted under the supervision of the manufacturer's technical representative.
- B. The equipment system supplier shall furnish the services at site of a factory-trained representative for a period of three (3) - eight (8) hours working days to the jobsite. Service shall be provided after the Contractor has installed the equipment. These services shall be furnished for the purposes of:
 - 1. The equipment manufacturer's inspection of the equipment following installation by others, and to certify that the equipment has been properly installed and is ready to operate.
 - 2. Conduct the equipment Performance Testing.
 - 3. To train the Owner's personnel in the operation, maintenance of the equipment, and to observe and supervise the initial operation of the equipment.
- C. If additional service is required due to the mechanisms not being fully operational, at the time of service requested by the contractor, the additional service days will be at the contractor's expense.
- D. After inspection of the installed equipment the Supplier shall furnish a written report certifying that the equipment has been properly installed and lubricated, is in accurate alignment, is free from any undue stress imposed by connecting piping or anchorage, has been operated under full load conditions and that it operates satisfactorily.

3.6 DEMONSTRATION AND INSTRUCTIONS

- A. Provide the services of a qualified factory-trained manufacturer's representative to conduct training covering operation, mechanical maintenance, electrical requirements, troubleshooting and etc.

3.7 OPERATION AND MAINTENANCE MANUALS

- A. Prior to or with the delivery of equipment, the manufacturer shall provide copies of an operation and maintenance manual including storage, installation, start-up, operating and maintenance instructions and a complete parts list and recommended spare parts list. The O & M manuals shall be in compliance with the General Requirements.

END OF SECTION 467331

SECTION 467400 - OPEN CHANNEL FLOW METERING SYSTEM

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.
- B. Design, fabricate and Parshall Flumes and materials in accordance with manufacturer's recommended procedures and the following codes and standards:
 - 1. ASTM A193 – Stainless Steel Anchor Bolts
 - 2. ASTM D256 – Izod Impact Strength
 - 3. ASTM D570 – Water Absorption Rate
 - 4. ASTM D638 – Tensile Strength
 - 5. ASTM D695 – Compressive Properties of Rigid Plastic
 - 6. ASTM D696 – Coefficient of Linear Expansion
 - 7. ASTM D790 – Flexural Properties
 - 8. ASTM D792 – Density and Specific Gravity at 23°C
 - 9. ASTM D1056 – Polymer Grade
 - 10. ASTM D2583 – Indentation Hardness
 - 11. ASTM D2584 – Resin, Glass & Filler Content
 - 12. ISO1438/1-1980 – Open Channel Flow Measurement

1.2 SUMMARY

- A. This section includes furnishing and installing a Parshall Flume in an open channel for metering effluent flow, ultrasonic flow sensor, transmitter, totalizer and other appurtenances required for a complete installation.
- B. Parshall Flume Design Conditions:
 - 1. The wastewater flow rates measured by the Parshall Flume are:
 - a. Average Day Design Flow: 2 MGD
 - b. Minimum Flow: 0.112 MGD
 - c. Max Flow Rate: 15.9 MGD
 - 2. Parshall Flume shall be cable measure flow under free flow condition.
- C. The Contractor shall be responsible for the purchase, storage, and installation of the Parshall Flume, ultrasonic flow sensor, transmitter, totalizer and any accessories required. The devices shall be completely wired, tested, and be suitable for operation. The wiring between the devices and the power supply, and the wiring between the ultrasonic flow sensors, totalizer and transmitters shall be the responsibility of the Contractor. The Drawings and Specifications are intended to illustrate and define the equipment installation; however, the Contractor shall

properly install, adjust, and place in operation the complete installation. The Contractor shall assume full responsibility for additional costs which may result from unauthorized deviations from the Specifications.

1.3 QUALITY ASSURANCE

- A. In addition to requirements of these specifications, comply with manufacturer's instructions and recommendations for work.
- B. Manufacturer shall be experienced in the design and manufacture of specific Parshall Flumes and accessories for a minimum period of 20 years.
- C. All equipment shall be of the latest and most modern design. All sensor/transmitter assemblies shall be of the same manufacturer and general model type.
- D. The flume fabrication, engineering and customer support shall all be provided by the same company. Outsourcing any of these components is not acceptable.
- E. To assure quality control and single source accountability the same manufacturer shall fabricate and fully assemble the flume and all components.

1.4 SUBMITTALS

- A. The Contractor shall submit manufacturer's technical data and application instruction in accordance with the General and Supplementary Conditions and Division 1 Specifications and any additional information listed herein.
- B. Product Data: Submit manufacturer's technical data and application instructions.
- C. Shop Drawings: All shop drawings shall clearly identify the specific equipment and material being supplied, the quantity being supplied, and all accessories, dimensions, descriptions, mounting and connection details, and any other information necessary to determine compliance with the plans and specifications:
 - 1. Show all critical dimensions.
 - 2. Provide principal parts and materials.

1.5 WARRANTY

- A. Manufacturer must provide warranty for 25 years against failure due to corrosion.

1.6 DELIVERY, STORAGE AND HANDLING

- A. Ship all Parshall Flumes with suitable packaging to protect products from damage.
- B. Protect flume flanges, tabs and accessories from damage.
- C. The flume shall be stored on a smooth flat surface, free of sharp objects, and if laid horizontally, shall be placed in such a way as to avoid structural damage.

PART 2 - PRODUCTS

2.1 MANUFACTURER

A. Parshall Flume Manufacturers:

1. Plasti-Fab, Inc.
2. Kenco Plastics, represented by Chaltron Systems, Inc.
3. Or Engineer approved equal.

B. The flow transmitter and sensor shall be as manufactured by:

1. Nivelco USA, LLC, Model W200, represented by Chaltron Systems, Inc., www.chaltron.com.
2. Or Engineer approved equal.

C. Totalizing Recorders Manufacturer:

1. Chaltron Systems, Model CSI-NANO-102, represented by Chaltron Systems, Inc., www.chaltron.com.
2. Or Engineer approved equal.

2.2 MATERIAL OF CONSTRUCTION

- #### A. Composition of the Parshall Flume laminate shall be in accordance with the recommendations shown in the Quality Assurance Report for Reinforced Thermoset Plastic (RTP) Corrosion Resistant Equipment prepared under the sponsorship of the Society of the Plastics Industry, Inc. (SPI), and the Material Technology Institute (MTI) of the Chemical Process Industry for "Hand Lay-Up Laminates," and shall meet the specifications for Type I, Grade 10 laminates shown in Appendix M-1 of said report.

2.3 METERING FLUME

A. Flume

1. Flume throat size shall be of 18 inch.
2. The metering flume shall be embedded in poured concrete and shall be a fiberglass reinforced polyester.
3. The outside surface shall be provided with clips suitable for anchoring the flume in concrete.
4. Flume shall be molded to the exact dimensions specified.
5. The flume shall have a minimum wall thickness of 1/4" throughout.
6. Flume inside surface shall be smooth, isophthalic gelcoat of 10 - 20 mil (0.25 - 0.51mm) thickness for UV resistance.
7. The inside surface shall free from irregularities and exposed reinforcing fibers.
8. The minimum glass content shall be 30% exclusive of gelcoat surfaces.
9. The flume shall be reinforced with box section stiffeners down the sides and across the bottom.

10. The stiffeners shall be joined at the knee to form a rigid dimensionally stable flume.
11. Reinforcing shall be designed to provide structural support throughout the length and width of the flume floor.
12. Flume shall be structurally designed to maintain dimensional integrity with a full head of water while being free standing.
13. Flume shall have a molded-in head gage with dual graduation in:
Left: GPM Right: FT
14. Stiffeners across the top shall be permanent FRP pultruded angle/channel or temporary wood spreaders as required for the job and shall provide sufficient strength and structural support to resist the stresses that occur during shipping and proper installation of the flume.

B. Physical Properties

1. FRP shall be approximately 30% fiberglass, 70% polyester resin and have all surfaces smooth, resin rich, free of voids and porosity, without dry spots, crazes, or unreinforced areas. Minimum properties required for FRP are:

Property	Minimum Value	Test
Tensile Strength	15,000 psi	ASTM D-638
Flexural Strength	20,000 psi	ASTM D-790
Flexural Modulus	1,000,000 psi	ASTM D-790
Compressive Strength	22,000 psi	ASTM D-695
Impact Strength	9 ft-lbs/in	ASTM D-256
Water Absorption	0.13%	ASTM D-570

C. Accessories

1. The flume shall include an adjustable stainless steel ultrasonic flow sensor mounting bracket.
2. Sample tube: Stainless steel sample pipe 3/8" OD for connection to the sampling and analyzer equipment. The tube shall be affixed to a removable bracket for easy maintenance. The bracket shall be mounted over a molded cavity that holds the tube out of the main flow path.
3. The flume shall conform to the physical dimensions listed in Chapter 8, Figure 9 of the U.S. Department of Interior Bureau of Reclamation, Water Measurement Manual, latest edition. Dimensional tolerances for all other sizes shall be plus or minus 1/8" maximum in the throat, and plus or minus 1/4" maximum elsewhere.

2.4 FLOW SENSOR AND TRANSMITTER

- A. The transmitter electronics shall be based on 80GHz Wide Band Radar technology and shall be immune from changes in dielectric, specific gravity, and vapors.

1. Configuration shall be through a SAP-300 dot matrix LCD local display with four push button controls and/or through an optional HART® interface using software in conjunction with a HART® modem or stand alone with a HART® hand-held terminal.
2. Calibration, with the need to move the process liquid, shall not be necessary.

3. Bench configuration of all configuration parameters of the unit (less false target rejection), prior to installation, shall be possible.
4. False Target Rejection will be performed effectively without the need for a secondary device (PC, laptop computer, HART® hand-held).
5. The transmitter will have the ability to effectively track rapid rates of level change up to 180"/minute.
6. The transmitter housing shall be directly coupled to the sensing antenna.
7. The unit shall be capable of rotating and positioning the polarization of the radar signal on the surface level, to optimize performance and facilitate installation and setup, at any point in 180° without removing the instrument from its secured, in-process mounting position.
8. The rotation and positioning of the polarization path shall be accomplished through the use of an internal indexed dial, fully accessible from the top of the unit. Units not allowing for rotation and positioning of the polarization path through an internal indexed dial shall not be acceptable.
9. The sensor shall consist of a microprocessor-based electronic Radar transmitter 80 GHz housed in a rugged, watertight, dust-tight, submersible, corrosion resistance (NEMA 4X, 6, and IP67) enclosure.
10. The transmitter shall operate as a 2-wire, 4–20 mA device from 12 to 36VDC. The 4–20 mA output shall operate from 3.8mA to 20.5mA (per Namur NE43) and have diagnostic fault values of 3.6mA, 22mA, and HOLD last value.
11. The minimum blocking distance shall be 15" as measured from bottom of the process connection (NPT) threads.
12. The unit shall have the ability to be mounted to reduce the unusable area near the tank top to 3" or less.
13. The sensor shall include variable blocking distance to ignore echoes from within a programmable distance from the sensor.
14. The maximum measuring range shall be 30'.
15. The transmitter will be approved for General Purpose.
16. The sensor shall transmit and receive a radar signal to accurately measure fluid depth at the monitoring site. The level measurement span shall be from 0–30' with the following characteristics:
 - a. Linearity – $\pm 0.2"$ or 0.05% of tank height
 - b. Measured Error – $\pm 0.2"$ or 0.05% of tank height
 - c. Resolution – 0.01"
 - d. Repeatability – $\pm 0.2"$ or 0.05% of tank height
17. The ambient temperature rating shall be -22°F to +176°F.
18. The sensor shall not require built-in temperature compensation to automatically compensate for air temperature changes.
19. The sensor shall have manual gain and averaging adjustments to maximize performance in the presence of steam, turbulence, and other process variables.
20. The sensor shall also have adaptive averaging capability that automatically adjusts for changing process conditions for real time.

- B. Transducer
 - 1. The antenna shall be a fully encapsulated horn style; all wetted surfaces will be PVDF.
 - 2. The antenna shall be a radome design and shall utilize a dielectric window to maximize performance. Units without the radome/dielectric window functionality will not be acceptable.
 - 3. Connection size for the unit shall be 1" NPT.

- C. Indicating, Totalizing Recorders
 - a. The paperless recorder shall be supplied with (4) universal inputs and (14) virtual channels that can be configured for calculations, totalizers and counters.
 - b. The recorder shall be a compact design with a 3.5" TFT display and include horizontal and vertical trends, bar graphs, numeric and alarm status displays.
 - c. The recorder shall have a 50 Mb internal memory, with Ethernet communications and a USB removable data storage facility. Historical data review software shall be included.
 - d. The recorder shall be a Eurotherm Nanodac or approved equal. The recorder shall be mounted in a NEMA 4X Polycarbonate Enclosure suitable for wall mounting with an IP67 front USB port.
 - e. The recorder shall include a 24 VDC Transmitter Power Supply to provide power to the flow sensor.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. The equipment shall be installed in accordance with the plans and the manufacturer's recommendations.

- B. It is the intent of this contract that the final installation shall be complete in all respects and the Contractor shall be responsible for minor details and any necessary special construction not specifically included in the Drawings or Specifications.

3.2 MANUFACTURER'S SERVICES

- A. The ultrasonic flow sensor and transmitter manufacturer shall provide the services of a qualified service engineer to supervise and inspect the equipment installation to insure that it is installed in accordance with the manufacturer's recommendations.

- B. The manufacturer's service engineer shall field calibrate all equipment specified under this Section. This service shall be performed at the request of the Project Engineer at the time of complete plant startup at the end of the last construction contract. A calibration certificate shall be submitted to the Project Engineer for each piece of equipment. The service engineer shall also make all adjustments necessary to place the equipment in trouble-free operation. In addition, the equipment manufacturer shall provide a qualified service engineer to train the plant operating personnel in the proper care, repair, calibration and operation of the equipment. This service shall be provided at the location and time requested by the Owner.

3.3 OPERATION AND MAINTENANCE MANUALS

- A. Prior to or with the delivery of equipment, the manufacturer shall provide copies of an operation and maintenance manual including storage, installation, start-up, operating and maintenance instructions, and a complete parts list and recommended spare parts list.

END OF SECTION 467400

SECTION 6
SPECIFIC PROJECT REQUIREMENTS

SPECIFIC PROJECT REQUIREMENTS

1 - CONTACT DURING BIDDING

- 1.1 All questions during bidding should be addressed to Marina Sher, P.E. who can be reached at CT Consultants, Inc., at CT21000706@ctconsultants.com

2 - CORRECTION PERIOD

- 2.1 The Correction Period in Section 13.07 of the General Conditions shall be changed from a one (1) year to a two (2) year period.

3 - GEOTECHNICAL REPORT

- 3.1 A geotechnical report dated July 2002 by BBC&M Engineering, Inc. was relied upon by the Engineer in the preparation of drawings and specifications. Copies of the report are provided along with each bid set but are not considered to be part of the contract documents.

4 - ASBESTOS SURVEY REPORT

- 4.1 A NESHAP Asbestos and Lead Based Paint Survey dated 01/26/24 by CT Consultants, Inc. was relied upon by the Engineer in the preparation of drawings and specifications. Copies of the report are provided along with each bid set but are not considered to be part of the bid documents.

5 - REFERENCE DRAWINGS

- 5.1 Reference Drawings dated 2004 of the Village of Sunbury, Ohio WWTP Improvements, Contract No. 2002-02 were relied upon by the Engineer in the preparation of drawings and specifications. Copies of the drawings may be examined on the internet at <https://bids.ctconsultants.com> but are not considered to be part of the bid documents.

6 - INSURANCE

- 6.1 Section SC-5.04(D) of the Supplementary Conditions shall be deleted and no "all risk builders risk" or "installation floater" insurance need be purchased by the Contractor.
- 6.2 See the following Bid Set Sections for Insurance Requirements:
- A. Section 1, Instructions to Bidders, Part 10 Insurance
 - B. Section 3, General Conditions, Article 5 Bonds and Insurance (EJCDC) or Article 11 Insurance and Bonds (AIA), whichever is used in the Bid Set
 - C. Section 4, Supplemental Conditions

7 - WORKING HOURS

- 7.1 No work shall be performed between the hours of 7:30 p.m. and 7:30 a.m. nor on Saturday, Sunday, or legal Holidays, without written permission of the Owner.

8 - PROJECT COMPLETION

- 8.1 All work including restoration and clean-up shall be completed no later than the contract completion date. Failure to complete all work within the allotted time will result in assessment of liquidated damages. Upon completion of all work and written notification of same by the Contractor, the Engineer and Owner will compile a punch list. The punch list will be sent to the Contractor. All punch list work shall be completed to the satisfaction of the Engineer and the Owner within 30 days after receipt of the punch list. Failure to complete the punch list work within the allotted time will result in assessment of liquidated damages.

9 - DRUG-FREE WORKPLACE PROGRAM

- 9.1 In accordance with Ohio Revised Code §153.03 and during the life of this project, the Contractor and all its Subcontractors that provide labor on the Project site must be enrolled in and remain in good standing in the Ohio Bureau of Worker's Compensation ("OBWC") Drug-Free Workplace Program ("DFWP") or a comparable program approved by the OBWC.

10 - OHIO ETHICS LAW

- 10.1 Contractor agrees that it is currently in compliance and will continue to adhere to the requirements of Ohio Ethics law as provided by Section 102.03 and 102.04 of the Ohio Revised Code.

11 - PERIODIC PAYMENTS

- 11.1 This project is expected to be funded in whole or in part by the Ohio EPA **WPCLF** Program. The Contractor shall comply with all requirements of this program. The periodic payments to the Contractor may be made in whole or in part through the OWNER and/or OWDA. In paragraph 14.02 C.1. of the General Conditions, change "ten days" to "sixty days."
- 11.2 Ohio EPA must approve all change orders prior to a change order item being paid on a pay estimate.

END OF SECTION

SECTION 7
SPECIAL REQUIREMENTS - EPA

Contract Document Provisions

The following contract requirements and forms are to be included in the construction contract documents. Completed copies of the forms are to be submitted to Ohio EPA within one week after bids are received, or sooner dependent on your individual project schedule. Bid packages for WPCLF projects should be submitted to DEFA in the central office while bid packages for WSRLA projects should be submitted to the appropriate DDAGW district office.

Equal Employment Opportunity (EEO) Requirements

The Contractor's EEO Certification Form must be (1) included in the contract documents and (2) referenced in the Instructions to Bidders, informing bidders that the form must be completed and submitted with their bid.

NOTE: If the loan applicant has its own EEO requirements, local procedures and forms may be substituted for the EPA form.

Debarment

The Certification Regarding Debarment, Suspension, and Other Responsibility Matters must be (1) included in the contract documents and (2) referenced in the Instructions to Bidders, informing bidders that the form must be completed and submitted with their bid.

Disadvantaged Business Enterprises (DBE) Utilization

The DBE Specification language and instructions to the bidders and Forms 6100-3, 6100-4 and 6100-2 must be (1) included in the contract documents and (2) referenced in the Instructions to Bidders, informing bidders that the forms must be completed and submitted with their bid.

NOTE: If the loan applicant has its own DBE requirements or if other funding programs with potentially competing DBE requirements are participating in the project funding, please contact Ohio EPA – DEFA for specific instructions regarding the DBE requirements.

Davis-Bacon wage rate requirements

The contract documents must include language that requires contractors and subcontractors to pay wages at rates not less than those prevailing on similar projects within the area as determined by the US Secretary of Labor. In addition, the loan recipient will be required to conduct wage interviews and monitor payroll for compliance.

American Iron and Steel

All treatment works projects funded by a WPCLF assistance agreement and all public water system projects funded by a WSRLA assistance agreement are required to comply with American Iron and Steel (AIS) requirements. The acknowledgement form must be included in the contract documents. The acknowledgement form should be signed by the contractor and submitted with the final bid package. It is recommended that the AIS guidance document and questions and answers document be included in the contract documents.

Bipartisan Infrastructure Law Signage Requirements

The Bipartisan Infrastructure Law (BIL) mandates that recipients of BIL funding must install a sign in compliance with the design specifications provided by the United States Environmental Protection Agency (USEPA). These signs should be placed either on the construction site or in a location that is easily visible and directly relevant to the respective construction project. BIL-specific signage is applicable to all construction projects that receive funding under BIL, including those related to Lead Service Line, Emerging Contaminants, and equivalency projects.

Equivalency projects include projects that receive funding through federal capitalization grants supporting the Water Pollution Control Loan Fund (WPCLF) and the Water Supply Revolving Loan Account (WSRLA) programs. For all BIL-funded and equivalency projects, recipients are responsible for ensuring that a sign is prominently displayed at the construction site. This sign should feature the official “Investing in America” emblem and clearly identify the project as “funded by President Biden’s Bipartisan Infrastructure Law.”

These signs must be placed in locations that are easily visible, directly associated with the ongoing work, and they should be maintained in good condition throughout the entire construction period. Signage guidelines and design specifications provided by EPA for using the official Investing in America emblem are available at: <https://www.epa.gov/invest/investing-america-signage>.

The following contract requirements are to be included in the construction contract documents but are not required to be submitted to Ohio EPA for contract endorsement.

Violating Facilities Clause

Language prohibiting this use of equipment or services from anyone on the EPA List of Violating Facilities must be included in the contract documents.

Small Businesses in Rural Areas (SBRA)

Language encouraging the participation of small businesses in rural areas should be included in the contract documents.

Prohibition on Telecommunications and Video Surveillance

Restrictions to loan recipients and subrecipients on certain telecommunications and video surveillance services or equipment due to Public Law 115-232.

Insurance Provisions

Section 3.5 of the WPCLF/WSRLA Loan Agreement contains specific requirements regarding insurance for all contractors and all subcontractors for the life of the contract. These insurance requirements must be reflected in the contract documents. Adjust the language as needed to meet the specifics of the construction project while still meeting the provisions of the Loan Agreement.

Materials Testing

In addition to the details included with specific equipment testing in the specifications, there should be an overall statement regarding testing for the project. Adjust the language as needed to meet the specifics of the construction project.

Continuous Treatment Provisions

It is important that construction activities not result in any temporary violations of Drinking Water or NPDES permit requirements (for permitted facilities). Construction activities should interrupt wastewater service to the individual resident as little as possible. For drinking water projects, it is important that construction activities not result in any disruption of service. The example language is intended for construction work occurring at an existing drinking water plant or a WWTP and must be adjusted to meet the specifics of the construction project.

WPCLF/WSRLA Change Order Form

All change orders for the construction project must be executed on the WPCLF/WSRLA change order form. The form must be (1) included in the contract documents and (2) the instructions referenced in the Contract Documents.

The following contract requirements are provided in Ohio Revised Code (ORC). Some loan applicants have local requirements that supersede ORC provisions for competitive bidding, and these local requirements can be applied instead of ORC, except for those requirements specified in the WPCLF/WSRLA loan agreements.

Bid Guarantee

The requirements for a bid guarantee (which can be a bond or a certified check, cashier's check, or letter of credit) are covered in ORC 153.54.

Payment and Performance Bonds

The requirements for a Payment and Performance Bond are covered in ORC 153.54 and Section 3.4 of the WPCLF/WSRLA Loan Agreements.

Payment Retention

The requirement for payment retainage is provided in ORC 153.12. Details on how the escrow account that holds the retainage are provided in ORC 153.13. Further details on how and when to pay for materials delivered and installed are provided in ORC 153.14.

Completion Time

The contract documents must state the length of the contract time per ORC 153.19. The dates for Initiation of Operation and Project Completion are specified in the WPCLF/WSRLA Loan Agreements and need to coincide with the specified contract time.

The following are contract provisions to consider but are not required. The language provided for each are samples only and must be adjusted to reflect the specifics of the project and local needs.

[Local Protest Procedure](#)

Some statement as to when a valid protest must be filed, in what form it must be filed and who it must be filed with should be included. ORC 153.12 has some default procedures for handling disputes. If the owner wants more control than provided in ORC, a procedure needs to be spelled out in the Contract Documents.

[Basis and Method for Award](#)

The contract documents should include some language that clearly states what the Owner will consider when determining the successful bidder and to provide a clear basis for the Owner when they have a need to reject the low bidder and go with a different bidder.

[Payment Methods](#)

To minimize uncertainty and arguments that can slow down the progress of construction it is useful to provide language stating how and when the Contractor will get paid. In addition to ORC and other local requirements, the involvement of public funding Agencies such as the WPCLF, WSRLA, Ohio Public Works Commission and Community Development Block Grant impact the process and timing for payments.

Contract Documents Review

Whenever possible, all the provisions listed above must be included in the contract documents for the project prior to advertisement for bids. Ohio EPA's review for these contract provisions will occur as part of our normal detail plans and specifications review. The bidding documents are to be submitted to Ohio EPA for review regardless of whether a Permit to Install or a Plan Approval is required for the project.

After bidding has started:

In those cases when WPCLF or WSRLA funding is being requested after advertisement for bids has started, add all missing contract provisions, forms, and requirements via addendum.

After bids have been opened but before contracts have been signed:

If the bid advertisement period is over and bids have been opened, but the construction contract have not been signed yet, provide a draft contract change order which would be used to incorporate all missing contract provisions, forms, and requirements into the contract. This should be done in consultation with local legal counsel to address any potential bid protest concerns.

Construction contracts have already been signed:

If the construction contract has already been signed, a contract change order must be executed incorporating all missing contract provisions, forms, and requirements into the contract.

A [Contract Documents Review checklist](#) is provided here to help ensure that all requirements are included and to help expedite Ohio EPA's review of your documents.

Bid Package Submittals

Certain documents must be submitted to Ohio EPA within one week after bids are received, or sooner dependent on your individual project schedule. Please [look here for a complete list](#) of the required submittals.

NOTE: THE CONTRACT LANGUAGE SAMPLES PROVIDED HEREIN ARE EXAMPLES OF WHAT COULD BE INCLUDED IN ALL CONTRACTS THAT USE WPCLF OR WSRLA FUNDS. OHIO EPA MAKES NO CLAIMS REGARDING THE LEGALITY OF THESE CLAUSES WITH RESPECT TO STATE OR LOCAL LAW. IT IS IMPERATIVE THAT ANY PARTY INSERTING THESE CLAUSES INTO A CONTRACT VERIFY THAT THEY ARE LEGAL AND ENFORCEABLE ACCORDING TO STATE AND LOCAL LAWS, REGULATIONS, AND ORDINANCES.

Disadvantaged Business Enterprises (DBE) Utilization

USEPA has a program to encourage the participation of disadvantaged businesses in the construction activities funded by the Clean Water and Drinking Water SRF's. "DBE" is an all inclusive term that includes Minority Business Enterprises (MBE), Women Business Enterprises (WBE), Small Business Enterprises (SBE), Small Business in Rural Areas (SBRA), HUBZone Small Business, Labor Surplus Area Firms (LSAF), and other entities defined as socially and/or economically disadvantaged. While the WPCLF and WSRLA strongly encourage participation by all disadvantaged groups, specific participation goals are negotiated with USEPA only for Minority Business Enterprises and Women's Business Enterprises.

Goals

As a condition of receiving capitalization grants from U.S. EPA for the Water Pollution Control Loan Fund (WPCLF) and the Water Supply Revolving Loan Account (WSRLA), the Ohio EPA negotiates "fair share" Disadvantaged Business Enterprises (DBE) objectives with U.S. EPA. The current negotiated goals for construction related activities are 1.3% of all contracts to MBEs and 1.0% of all contracts to WBEs.

DBE Certification

Under the DBE program, qualified DBE's are those that have been certified as an MBE or WBE. Certifications can be obtained from a federal agency such as the Small Business Administration or the Department of Transportation or by an approved State agency. The Unified Certification Program (UCP) administered by the Ohio Department of Transportation (ODOT) can provide the necessary DBE certifications. Information on the UCP can be found at <http://www.ohioucp.org> as well as the ODOT website www.dot.state.oh.us/divisions/equalopportunity/pages/dbe.aspx.

DBE Qualifications

To qualify for MBE certification, businesses must be 51 percent owned and controlled by a U.S. citizen and Ohio resident belonging to an African American, Native American, Hispanic, or Asian American ethnic group. In addition, the business must be in operation for at least one year prior to submitting an application. For DBE status, a business must be at least 51 percent owned by a socially and economically disadvantaged person who participates in the daily operations of the business. This person must be a woman or of African-American, Hispanic, Native American, Asian American ethnicity.

Program Requirements

To comply with DBE program requirements the WPCLF/WSRLA loan recipient must do the following:

1. Create and maintain a bidder's list (see description below)

2. Include contract conditions applicable to the DBE program in all procurement contracts entered into by the Borrower for all WPCLF and WSRLA projects. These conditions are listed below.
3. Follow, document, and maintain documentation of good faith efforts on the part of prime contractors to ensure that Disadvantaged Business Enterprises (DBEs) have the opportunity to participate in the project.
4. Review the Form 6100-3 and 6100-4 submittals provided by bidders on the project for completeness and obtain any additional information necessary to verify the certification status of all proposed subcontractors.
5. Obtain documentation of the good faith efforts of the prime contractor if the prime contractor does not meet the MBE or WBE goal.
6. Obtain a written confirmation from any prime contractor states that they will not meet the MBE and WBE goals because they will not be entering into any agreements for goods or services with any company, firm, joint venture, or individual.
7. Submit the following to the Ohio EPA/DEFA as part of the bid package upon which the WPCLF/WSRLA loan amount is determined:
 - Form 6100-3 from each subcontractor
 - Form 6100-4 from each prime contractor
 - a copy of the Good Faith Efforts documentation from any prime contractors that will not meet the MBE and WBE goals,
 - if any of the prime contractors will not meet the MBE and WBE goals because they will not be entering into any agreements for goods or services with any company, firm, joint venture, or individual, a copy of the written confirmation from that prime contractor
8. Report MBE/WBE accomplishments on Form 5700-52A annually (within 15 days after October 1st).

NOTE: It is up to the WPCLF/WSRLA loan recipient whether or not to require completion and submission of Forms 6100-3 and 6100-4 from all bidders with the bid proposal or to accept completion and submission from the successful bidder(s) only at some time after bids are received. Regardless of whether the forms are completed and submitted with the bids or at some later time once the successful bidders are identified, completed forms are to be submitted to Ohio EPA with the bid package.

To comply with DBE program requirements all prime contractors must do the following:

1. Follow, document, and maintain documentation of their good faith efforts.
2. Complete and submit **Form 6100-4 DBE Subcontractor Utilization Summary** as part of the bid proposal package to the loan recipient.
3. Have its Disadvantaged Business Enterprise subcontractors complete **Form 6100-3 DBE Subcontractor Proposed Performance Form** and submit those as part of the bid proposal package to the loan recipient.
4. Provide **Form 6100-2 DBE Subcontractor Actual Participation Form** to all of its Disadvantaged Business Enterprise subcontractors for completion at the end of the work.
5. During construction, provide the data necessary so that the loan recipient can report MBE/WBE accomplishments on Form 5700-52A annually (within 15 days after October 1st).

Bidders List

The Borrower must create, maintain, and use a bidders list for purposes of soliciting both MBE/WBEs and non-MBE/WBEs during procurement of construction, equipment, supplies, and services. This list shall include:

1. Entity's name with point of contact;
2. Entity's mailing address, telephone number, and e-mail address;
3. The procurement on which the entity bid or quoted, and when; and
4. Entity's status as an MBE/WBE or non-MBE/WBE.

Borrowers that receive less than \$250,000 or less in any one fiscal year can be exempt from maintaining a Bidders List.

The Bidders List shall be maintained until the project period has expired and the Borrower is no longer receiving EPA funding. The Bidders List must include all firms that bid on the prime contracts, or bid or gave a quote on subcontracts, including both MBE/WBEs and non-MBE/WBEs.

Required Contract Conditions

The DBE Specification language and instructions to the bidders and Forms 6100-2, 6100-3 and 6100-4 must be included in the contract documents and referenced in the Instructions to Bidders, informing bidders that the forms must be completed and submitted with their bid for all WPCLF and WSRLA projects:

1. The prime contractor must pay its subcontractor for satisfactory performance no more than 30 days from the prime contractor's receipt of payment from the owner.
2. The prime contractor must notify the owner in writing prior to the termination of any Disadvantage Business Enterprise subcontractor for convenience by the prime contractor.
3. If a Disadvantage Business Enterprise contractor fails to complete work under the subcontract for any reason, the prime contractor must employ the six Good Faith Efforts (listed below) if soliciting a replacement contractor.
4. The prime contractor must employ the six Good Faith Efforts even if the prime contractor has achieved its fair share objectives.
5. An owner must ensure that each procurement contract it awards contains the following terms and conditions:

The contractor shall not discriminate on the basis of race, color, national origin or sex in the performance of this contract. The contractor shall carry out applicable requirements of 40 CFR Part 33 in the award and administration of contracts awarded under EPA financial assistance agreements. Failure by the contractor to carry out these requirements is a material breach of this contract which may result in the termination of this contract or other legally available remedies.

Good Faith Efforts

Borrowers and their prime contractors must follow, document, and maintain documentation of their good faith efforts as listed below to ensure that Disadvantaged Business Enterprises (DBEs) have the opportunity to participate in the project by increasing DBE awareness of procurement efforts and outreach.

1. Ensure DBEs are made aware of contracting opportunities to the fullest extent practicable through outreach and recruitment activities; including DBEs on solicitation lists and soliciting them whenever they are potential sources.
2. Make information on forthcoming opportunities available to DBEs and arrange time frames for contracts and establish delivery schedules, where the requirements permit, in a way that encourages and facilitates participation by DBEs in the competitive process. This includes, whenever possible, posting solicitation for bids or proposals for a minimum of 30 calendar days before the bid or proposal closing date.
3. Consider in the contracting process whether firms competing for large contracts could be subcontracted with DBEs. This will include dividing total requirements when economically feasible into smaller tasks or quantities to permit participation by DBEs in the competitive process.
4. Encourage contracting with a consortium of DBEs when a contract is too large for one of these firms to handle individually.
5. Use the services and assistance of the Small Business Administration and the Minority Business Development Agency of the U.S. Department of Commerce.
6. If the prime contractor awards subcontracts, require the prime contractor to take the steps in numbers 1 through 5 above.

DBE Forms

Form 6100-3 – Each prime contractor must have its DBE subcontractors complete **Form 6100-3 DBE Subcontractor Proposed Performance Form**. This form gives the DBE subcontractor the opportunity to report the scope and cost of the subcontract and it should be forwarded to the Prime Contractor along with the DBE's quote. Each subcontractor completes one Form 6100-3. The Borrower must submit all Form 6100-3 forms to the Ohio EPA/DEFA as part of the bid package upon which the WPCLF/WSRLA loan amount is determined.

Form 6100-4 – Each prime contractor must complete and submit **Form 6100-4 DBE Subcontractor Utilization Summary** as part of the prime contractor's bid proposal package to the Borrower. This form summarizes the Prime Contractor's intended use of identified DBE(s) and the estimated dollar amount of each subcontract. Only one Form 6100-4 form is required from each Prime Contractor. The Borrower must submit this form to the Ohio EPA/DEFA as part of the bid package upon which the WPCLF/WSRLA loan amount is determined.

Form 6100-2 - The prime contractor must provide **Form 6100-2 DBE Subcontractor Actual Participation Form** to all of its Disadvantaged Business Enterprise subcontractors.

Reporting During Construction – Form 5700-52A

The purpose of MBE/WBE reporting is to monitor the grant recipient's accomplishments in utilizing MBEs and WBEs; and adherence to the good faith efforts (i.e., outreach to MBEs, WBEs, and other DBEs); and progress in achieving MBE and WBE Goals. During the progress of the construction project, the loan recipient must complete & submit Form 5700-52A annually (**within 15 days after October 1st**). If there were no MBEs or WBEs utilized, or no procurement expenditures of any kind were made during the reporting period, a "negative report" is still required.

Reports are to be sent to:

Florel Fraser, Ohio EPA – DEFA
P.O. Box 1049
Columbus, OH 43216-1049
E-mail address: Florel.Fraser@epa.ohio.gov
Phone: (614) 644-3636

**Disadvantaged Business Enterprise (DBE) Program
DBE Subcontractor Participation Form**

An EPA Financial Assistance Agreement Recipient must require its prime contractors to provide this form to its DBE subcontractors. This form gives a DBE¹ subcontractor² the opportunity to describe work received and/or report any concerns regarding the EPA-funded project (e.g., in areas such as termination by prime contractor, late payments, etc.). The DBE subcontractor can, as an option, complete and submit this form to the EPA DBE Coordinator at any time during the project period of performance.

Subcontractor Name		Project Name	
Bid/ Proposal No.	Assistance Agreement ID No. (if known)	Point of Contact	
Address			
Telephone No.		Email Address	
Prime Contractor Name		Issuing/Funding Entity:	

Contract Item Number	Description of Work Received from the Prime Contractor Involving Construction, Services , Equipment or Supplies	Amount Received by Prime Contractor

¹ A DBE is a Disadvantaged, Minority, or Woman Business Enterprise that has been certified by an entity from which EPA accepts certifications as described in 40 CFR 33.204-33.205 or certified by EPA. EPA accepts certifications from entities that meet or exceed EPA certification standards as described in 40 CFR 33.202.

² Subcontractor is defined as a company, firm, joint venture, or individual who enters into an agreement with a contractor to provide services pursuant to an EPA award of financial assistance.

ALERT

“Total Procurement” fields and “MBE/WBE Combined Procurement” fields located in section 4B of this form should include Federal funds provided under the assistance agreement, recipient matching funds, and funds from other sources that are included in the assistance agreement.

Due to process time of Paperwork Reduction Act procedures, EPA is not able to update the [EPA Form 5700-52A](#) immediately to reflect this clarification.

If EPA grant recipients have questions about [EPA Form 5700-52A](#), please work with your respective Grants Specialist or [DBE Coordinator](#).



U.S. ENVIRONMENTAL PROTECTION AGENCY MBE/WBE UTILIZATION UNDER FEDERAL GRANTS AND COOPERATIVE AGREEMENTS

This collection of information is approved by OMB under the Paperwork Reduction Act, 44 U.S.C. 3501 et seq. (OMB Control No. 2030-0020). Responses to this collection of information are required to obtain an assistance agreement (40 CFR Part 30, 40 CFR Part 31, and 40 CFR Part 33 for awards made prior to December 26, 2014, and 2 CFR 200, 2 CFR 1500, and 40 CFR Part 33 for awards made after December 26, 2014). An agency may not conduct or sponsor, and a person is not required to respond to, a collection of information unless it displays a currently valid OMB control number. The public reporting and recordkeeping burden for this collection of information is estimated to be 1 hour per response. Send comments on the Agency's need for this information, the accuracy of the provided burden estimates and any suggested methods for minimizing respondent burden to the Regulatory Support Division Director, U.S. Environmental Protection Agency (2821T), 1200 Pennsylvania Ave., NW, Washington, D.C. 20460. Include the OMB control number in any correspondence. Do not send the completed form to this address.

1A. REPORTING PERIOD October 1, _____ – September 30, _____		1B. REPORT TYPE <input type="checkbox"/> Annual <input type="checkbox"/> Final Report (Project completed)													
1C: Revision of a Prior Year Report? <input type="radio"/> No <input type="radio"/> Yes If yes, what reporting period is being revised and briefly describe the changes made. Note: The revised report will replace the associated original report in its entirety.															
2A. RECIPIENT UNIQUE ENTITY IDENTIFIER 															
2B. RECIPIENT REPORTING CONTACT Name: Email: Phone:															
3. FEDERAL AWARD IDENTIFICATION NUMBER (FAIN) (For SRF state recipients, please include all numbers for all open assistance agreements being reported on this form.)															
4A. If NO procurements were made this reporting period (by the recipient, sub-recipient(s), loan recipient(s), and prime contractor(s)), CHECK and SKIP to Block No. 6. (Procurements are all expenditures through contract, order, purchase, lease or barter of supplies, equipment, construction, or services needed to complete Federal assistance programs.) <input type="checkbox"/>															
4B. Total Procurements & MBE/WBE Accomplishments This Reporting Period (in dollars) <table style="width: 100%; border-collapse: collapse; margin-top: 10px;"> <thead> <tr> <th style="width: 60%;"></th> <th style="width: 15%; text-align: center;">Construction</th> <th style="width: 15%; text-align: center;">Non-Construction</th> <th style="width: 10%; text-align: center;">Total</th> </tr> </thead> <tbody> <tr> <td>Total Procurement:</td> <td style="text-align: center;">\$ _____</td> <td style="text-align: center;">\$ _____</td> <td style="text-align: center;">\$ _____</td> </tr> <tr> <td>MBE/WBE Combined Procurement:</td> <td style="text-align: center;">\$ _____</td> <td style="text-align: center;">\$ _____</td> <td style="text-align: center;">\$ _____</td> </tr> </tbody> </table>					Construction	Non-Construction	Total	Total Procurement:	\$ _____	\$ _____	\$ _____	MBE/WBE Combined Procurement:	\$ _____	\$ _____	\$ _____
	Construction	Non-Construction	Total												
Total Procurement:	\$ _____	\$ _____	\$ _____												
MBE/WBE Combined Procurement:	\$ _____	\$ _____	\$ _____												
5A. Good Faith Efforts: If procurements were made, indicate whether your organization has followed the six Good Faith efforts found in 40 CFR Part 33, Subpart C, 40 CFR 33.501 and 2 CFR 200.321. <input type="checkbox"/> Yes, my organization has implemented and documented each of the six Good Faith Efforts on the procurements made during this reporting period. <input type="checkbox"/> No, my organization has not implemented and documented each of the six Good Faith Efforts on the procurements made during this reporting period.		5B. If procurements were made, but no MBE/WBE procurements are being reported, then check the applicable box(es) for the reason(s) why no MBE/WBE procurements were made. <input type="checkbox"/> No MBE/WBE(s) applied <input type="checkbox"/> No MBE/WBE(s) were qualified <input type="checkbox"/> Other: _____													
6. NAME OF RECIPIENT'S AUTHORIZED REPRESENTATIVE		TITLE													
7. SIGNATURE OF RECIPIENT'S AUTHORIZED REPRESENTATIVE		DATE													

Instructions:

A. General Instructions:

MBE/WBE utilization is based on 40 CFR Part 33 and 2 CFR Parts 200 and 1500. The reporting requirement reflects the change in the reporting threshold described in Recipient/ Applicant Information Notice-2018-G04 issued by EPA's Office of Grants and Debarment on September 7, 2018 (<https://www.epa.gov/grants/rain-2018-g04>). EPA Form 5700-52A must be completed annually by recipients of financial assistance agreements where the combined total of funds budgeted for procuring supplies, equipment, construction and services exceeds the current Simplified Acquisition Threshold as set by the Federal Acquisition Regulation at 48 CFR Subpart 2.1. This reporting requirement applies to all new and existing awards and voids all previous reporting requirements.

In determining whether the threshold is exceeded for a particular assistance agreement, the analysis must focus on funds budgeted for procurement under the supplies, equipment, construction, services or "other" categories, and include funds budgeted for procurement under sub- awards or loans.

Reporting will also be required in cases where the details of the budgets of sub-awards/loans are not clear at the time of the grant awards and the combined total of the procurement and sub-awards and/or loans exceeds the Simplified Acquisition Threshold.

For example, if the Simplified Acquisition Threshold is \$250,000, then if a recipient has \$300,000 budgeted under procurement, then completion of this report is required.

When reporting is required, all procurement actions are reportable, not just the portion which exceeds the Simplified Acquisition Threshold.

If at the time of award the budgeted funds exceed the Simplified Acquisition Threshold but actual expenditures fall below, a report is still required.

If at the time of award, the combined total of funds budgeted for procurements in any category is less than or equal to the Simplified Acquisition Threshold and is

maintained below the threshold, no DBE report is required to be submitted.

Recipients are required to report 30 days after the end of each federal fiscal year (i.e. October 30th), per the terms and conditions of the financial assistance agreement.

Final reports are due October 30th or 120 days after the end of the project period, whichever comes first.

MBE/WBE program requirements, including reporting, are material terms and conditions of the financial assistance agreement. Failure to comply may lead to termination of the financial assistance agreement which is then reported to the OMB-designated integrity and performance system accessible through SAM (currently FAPIIS) pursuant to 2 CFR 200.339(b).

B. Submission:

Recipients must submit completed forms to the point of contact associated with the awarding office for the applicable assistance agreement.

Information on specific points of contact for EPA's Headquarters and ten Regional Offices is located at:

<https://www.epa.gov/grants/frequently-asked-questions-disadvantaged-business-enterprises>

Questions regarding the completion of this form should be directed to the DBE Coordinator associated with the awarding office for the applicable assistance agreement. A list of the DBE Coordinators for each awarding office can be located here:

<https://www.epa.gov/grants/epa-dbe-program-coordinators>

c. Instructions:

1A. Specify Federal fiscal year this report covers. The Federal fiscal year runs from October 1st through September 30th (**e.g. November 29, 2020 falls within Federal fiscal year 2021**)

1B. Specify report type. Check the annual reporting box if this is an annual report. If it is a final report, check the final report box to indicate if the project is completed.

1C. Indicate if this is a revision to a previous year and provide a brief description of the revision you are making including what reporting period is being revised. The revised report will replace the associated original report in its entirety.

2A. Provide your organization's Unique Entity Identifier. More information about Unique Entity Identifier, including its meaning, can be found in 2 CFR Part 25.

2B. Identify the name and contact information for the person located within the recipient organization that can be contacted if questions arise from this report.

3. Provide the Federal Award Identification Number (FAIN) assigned by EPA. A separate report must be submitted for each Assistance Agreement.

***For SRF recipients:** In box 3 list numbers for ALL OPEN Assistance Agreements being reported on this form.

4A. Self-explanatory. **Note:** Procurement means expenditures under the supplies, equipment, construction, services or "other" categories, and include funds expended for procurement under sub-awards or loans.

4B. Provide the total dollar amount (in dollars) of **ALL** procurements awarded this reporting period by construction, non-construction, and grand total by the recipient, sub-recipients, and SRF loan recipients, **including** MBE/WBE expenditures, not just the portion which exceeds the threshold. For example: Actual dollars for procurement from the procuring office; actual contracts let from the contracts office; actual goods, services, supplies, etc., from other sources including the central purchasing/ procurement centers).

Provide the total dollar amount (in dollars) of MBE/WBE procurements **ONLY** awarded this reporting period by construction, non-construction, and grand total by the recipient, sub-recipients, SRF loan recipients, and prime contractors not just the portion which exceeds the threshold.

***For SRF recipients only:** In 4B, please enter the total annual procurement amount under all of your SRF Assistance Agreements. The figure reported in this section is **not** directly tied to an individual Assistance Agreement identification number. **(SRF state recipients report state procurements in this section)**

5A. Self-explanatory.

5B. If procurements were made during this reporting period, but no procurements with MBE(s) or WBE(s) are being reported, then select the reason why. If "Other" is chosen, please fill in with the reason.

6. Self-explanatory.

7. Self-explanatory.

****This data is requested to comply with provisions mandated by: statute or regulations (40 CFR Part 33 and/or 2 CFR Parts 200 and 1500); OMB Circulars; or added by EPA to ensure sound and effective assistance management. Accurate, complete data are required to obtain funding, while no pledge of confidentiality is provided.**

Material Suppliers

In October 2009, OEPA/DEFA made a clarification to their DBE Policy. If a Contractor subcontracts work and cannot meet the Goals with MBE/WBE Subcontractors, the Goals may be met by supplying equipment from MBE/WBE Suppliers.

Also, Contractors that do not subcontract work do not have to comply with the MBE/WBE requirements although all Contractors are strongly encouraged to break the work into subcontracts whenever feasible.

Violating Facilities Clause

Violating Facilities:

The Contractor agrees to comply with all applicable standards, orders or requirements under Section 306 of the Clean Air Act, 42 USC 1857 (h), Section 508 of the Clean Water Act, 33 USC 1368, Executive Order 11738, and EPA regulations, 40 CFR Part 32, which prohibits the use under non-exempt Federal contracts, grants, or loans of facilities included on the EPA List of Violating Facilities.

Requirement For Utilization Of Small Businesses In Rural Areas (SBRA)

This procurement is subject to the EPA policy of encouraging the participation of small businesses in rural areas. It is EPA policy that recipients of EPA financial assistance awards utilize the services of small businesses in rural areas (SBRAs), to the maximum extent practicable. The objective is to assure that such small business entities are afforded the maximum practicable opportunity to participate as subcontractors, suppliers and otherwise in EPA-awarded financial assistance programs. This policy applies to all contracts and subcontracts for supplies, construction, and services under EPA grants or cooperative agreements. Small purchases are also subject to this policy.

This procurement is subject to the EPA policy of encouraging the participation of small business in rural areas (SBRAs).

WPCLF Local Protest Procedure

Protests

A protest based upon an alleged violation of the procurement requirement may be filed against the OWNER's procurement action by a party with an adversely affected direct financial interest. The protest shall be filed with the Mayor. The OWNER shall determine the protest. The OWNER may request additional information or a hearing in order to resolve the protest.

A protest shall be filed as early as possible during the procurement process, but must be received by the OWNER no later than one week after the basis of the protest is known or should have been known, whichever is earlier. If the protest is mailed, the protester bears the risk of nondelivery with in the required time period.

A protest must clearly present the procurement requirement being protested, the facts which support the protest, and any other information necessary to support the protest.

Continuous Treatment Provisions

It is important that construction activities not result in any temporary violations of NPDES permit requirements (for permitted facilities) and construction activities should interrupt wastewater service to the individual resident as little as possible. For drinking water projects, it is important that construction activities not result in any disruption of service. Any disruption of service must be immediately reported to the Ohio EPA, Drinking Water Section of the appropriate district office.

Continuous Treatment (wastewater projects)

Federal regulations prohibit by-passing of any sewage during construction operations. The Contractor will be responsible for providing any required temporary pumping facilities piping, etc., necessary to complete the project without any plant by-passing and continuous treatment must be provided at the same level during construction as existed prior to construction.

Unless otherwise previously or subsequently specified, the Contractor shall procure and pay for all permits, licenses, and approvals necessary for the execution of his Contract.

The Contractor shall comply with all laws, ordinances, rules, orders, and regulations relating to the performance of the work required to complete their Contract.

The following example language is a sample of what might be appropriate for construction work occurring at an existing drinking water treatment plant. The language actually incorporated into the contract documents must be adjusted to meet the specifics of the construction project.

Continuous Treatment (drinking water projects)

The Contractor will be responsible for obtaining approval from Ohio EPA for use of temporary pumping facilities, piping and other items in order to complete the project without any plant by-passing. Continuous treatment must be provided at the same level during construction as existed prior to construction.

Unless otherwise previously or subsequently specified, the Contractor shall procure and pay for all permits, licenses, and approvals necessary for the execution of his Contract.

The Contractor shall comply with all laws, ordinances, rules, orders, and regulations relating to the performance of the work required to complete their Contract.

WPCLF/WSRLA Payments

This project is funded in whole or in part by funds from the Water Pollution Control Loan Fund (WPCLF) or the Water Supply Revolving Loan Account (WSRLA) as administered by the Ohio EPA-DEFA and the Ohio Water Development Authority (OWDA). The Contractor shall comply with all requirements of these programs. The Owner shall be responsible for the progress payments to the Contractor if the Owner becomes ineligible for further payments due to circumstances which are of no fault of the Contractor. The monthly payments to vendors may be made through the Owner, the OWDA, or both as deemed by the Owner.

The time frame for payment of pay estimates by the Owner and/or Special Funding Agency(s) may be up to 60 calendar days from date of receipt of pay estimate from Engineer to Owner. Ohio EPA/DEFA must approve all change orders before the change order may be submitted for payment on a pay estimate.

State of Ohio
 WATER POLLUTION CONTROL LOAN FUND (WPCLF) /
 WATER SUPPLY REVOLVING LOAN ACCOUNT (WSRLA)

CONTRACT CHANGE ORDER

RECIPIENT _____ CHANGE ORDER NBR _____

LOAN NUMBER _____ CONTRACT _____

OWDA PROJECT No. _____ DATE _____

Description of Change:

The time provided for completion in the contract for the above items is (increased/decreased) by ____ calendar days.

RECOMMENDED BY: _____ DATE: _____
 (Engineer)

APPROVED BY: _____ DATE: _____
 (Recipient)

ACCEPTED BY: _____ DATE: _____
 (Contractor)

 (Company)

Original Contract Amt	_____
Previous Changes (+ / --)	_____
This Change (+ / --)	_____
Adjusted Contract Amt	_____

OWDA APPROVAL
 The above proposal is hereby accepted and I recommend that it be approved and made a part of the contract noted above. The approval does not constitute an increase in the total loan amount, but represents approval for the work.

Ohio EPA Acceptance	Chief Engineer
Date	Date

CHANGE ORDER INSTRUCTIONS:

All Change Orders for this work, regardless of costs and whether Water Pollution Control Loan Fund (WPCLF) or Water Supply Revolving Loan Account (WSRLA) funding will be used to finance the changes, must be submitted to Ohio EPA for review.

Changes Requiring Prior Approval

Any change which substantially modifies the Project Facilities as specified in the Ohio EPA approved Facilities Plan and Final Permit to Install or Final Plan Approval (when applicable) or alters the direct or indirect impact of the Project Facilities upon the environment must be incorporated into a Change Order. One copy of the Change Order prior to execution is to be submitted to Ohio EPA for review and prior approval of the acceptability of the change. "Prior to execution" means before the Change Order is signed by the Owner.

Ohio EPA will review the Change Order and inform the Owner of the technical, environmental and operational acceptability of the change, and give the Owner permission to proceed with the proposed work.

All Other Changes

Change Orders not requiring prior approval as described above must be submitted to Ohio EPA within one (1) month of the time at which they are approved by the Owner. All change orders must be submitted electronically to dedicated change order email addresses for WPCLF and WSRLA projects.

Change Order Approval Process

After the Change Order is executed, one (1) copy of the Change Order, including the supporting documentation, is to be sent electronically to Ohio EPA for final review.

The dedicated e-mail address for the electronic submittal of WPCLF Change Orders is EPAWPCLFCO@epa.ohio.gov.

The dedicated e-mail address for the electronic submittal of WSRLA Change Orders is EPAWSRLACO@epa.ohio.gov.

After the Change Order is accepted and eligible costs determined, Ohio EPA will issue a letter informing the Owner and authorizing OWDA to disburse funds from Project Contingency for the work. The OEPA letter will be sent electronically along with a PDF of the WPCLF/WSRLA Change Order form which will be signed by all parties including Ohio EPA and OWDA.

Payments for Change Order Work

The Owner is precluded from submitting to the OWDA payment requests for Eligible Project Costs associated with the Change Orders until such time as the Ohio EPA's approval of the Change Orders has been obtained.



UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

MAR 20 2014

OFFICE OF WATER

MEMORANDUM

SUBJECT: Implementation of American Iron and Steel provisions of P.L. 113-76,
Consolidated Appropriations Act, 2014

FROM: f (Andrew D. Sawyers, Director
v) Office of Wastewater Management (4201M)
Peter C. Grevatt, Director
Office of Ground Water and Drinking Water (4601M)

TO: Water Management Division Directors
Regions I - X

P.L. 113-76, Consolidated Appropriations Act, 2014 (Act), includes an "American Iron and Steel (AIS)" requirement in section 436 that requires Clean Water State Revolving Loan Fund (CWSRF) and Drinking Water State Revolving Loan Fund (DWSRF) assistance recipients to use iron and steel products that are produced in the United States for projects for the construction, alteration, maintenance, or repair of a public water system or treatment works if the project is funded through an assistance agreement executed beginning January 17, 2014 (enactment of the Act), through the end of Federal Fiscal Year 2014.

Section 436 also sets forth certain circumstances under which EPA may waive the AIS requirement. Furthermore, the Act specifically exempts projects where engineering plans and specifications were approved by a State agency prior to January 17, 2014.

The approach described below explains how EPA will implement the AIS requirement. The first section is in the form of questions and answers that address the types of projects that must comply with the AIS requirement, the types of products covered by the AIS requirement, and compliance. The second section is a step-by-step process for requesting waivers and the circumstances under which waivers may be granted.

Implementation

The Act states:

Sec. 436. (a)(1) None of the funds made available by a State water pollution control revolving fund as authorized by title VI of the Federal Water Pollution Control Act (33 U.S.C. 1381 et seq.) or made available by a drinking water treatment revolving loan fund as authorized by section 1452 of the Safe Drinking Water Act (42 U.S.C. 300j-12) shall be used for a project for the construction, alteration, maintenance, or repair of a public water system or treatment works unless all of the iron and steel products used in the project are produced in the United States.

(2) In this section, the term “iron and steel products” means the following products made primarily of iron or steel: lined or unlined pipes and fittings, manhole covers and other municipal castings, hydrants, tanks, flanges, pipe clamps and restraints, valves, structural steel, reinforced precast concrete, and construction materials.

(b) Subsection (a) shall not apply in any case or category of cases in which the Administrator of the Environmental Protection Agency (in this section referred to as the “Administrator”) finds that—

(1) applying subsection (a) would be inconsistent with the public interest;

(2) iron and steel products are not produced in the United States in sufficient and reasonably available quantities and of a satisfactory quality; or

(3) inclusion of iron and steel products produced in the United States will increase the cost of the overall project by more than 25 percent.

(c) If the Administrator receives a request for a waiver under this section, the Administrator shall make available to the public on an informal basis a copy of the request and information available to the Administrator concerning the request, and shall allow for informal public input on the request for at least 15 days prior to making a finding based on the request. The Administrator shall make the request and accompanying information available by electronic means, including on the official public Internet Web site of the Environmental Protection Agency.

(d) This section shall be applied in a manner consistent with United States obligations under international agreements.

(e) The Administrator may retain up to 0.25 percent of the funds appropriated in this Act for the Clean and Drinking Water State Revolving Funds for carrying out

the provisions described in subsection (a)(1) for management and oversight of the requirements of this section.

(f) This section does not apply with respect to a project if a State agency approves the engineering plans and specifications for the project, in that agency's capacity to approve such plans and specifications prior to a project requesting bids, prior to the date of the enactment of this Act.

The following questions and answers provide guidance for implementing and complying with the AIS requirements:

Project Coverage

1) What classes of projects are covered by the AIS requirement?

All treatment works projects funded by a CWSRF assistance agreement, and all public water system projects funded by a DWSRF assistance agreement, from the date of enactment through the end of Federal Fiscal Year 2014, are covered. The AIS requirements apply to the entirety of the project, no matter when construction begins or ends. Additionally, the AIS requirements apply to all parts of the project, no matter the source of funding.

2) Does the AIS requirement apply to nonpoint source projects or national estuary projects?

No. Congress did not include an AIS requirement for nonpoint source and national estuary projects unless the project can also be classified as a 'treatment works' as defined by section 212 of the Clean Water Act.

3) Are any projects for the construction, alteration, maintenance, or repair of a public water system or treatment works excluded from the AIS requirement?

Any project, whether a treatment works project or a public water system project, for which engineering plans and specifications were approved by the responsible state agency prior to January 17, 2014, is excluded from the AIS requirements.

4) What if the project does not have approved engineering plans and specifications but has signed an assistance agreement with a CWSRF or DWSRF program prior to January 17, 2014?

The AIS requirements do not apply to any project for which an assistance agreement was signed prior to January 17, 2014.

5) What if the project does not have approved engineering plans and specifications, but bids were advertised prior to January 17, 2014 and an assistance agreement was signed after January 17, 2014?

If the project does not require approved engineering plans and specifications, the bid advertisement date will count in lieu of the approval date for purposes of the exemption in section 436(f).

6) What if the assistance agreement that was signed prior to January 17, 2014, only funded a part of the overall project, where the remainder of the project will be funded later with another SRF loan?

If the original assistance agreement funded any construction of the project, the date of the original assistance agreement counts for purposes of the exemption. If the original assistance agreement was only for planning and design, the date of that assistance agreement will count for purposes of the exemption only if there is a written commitment or expectation on the part of the assistance recipient to fund the remainder of the project with SRF funds.

7) What if the assistance agreement that was signed prior to January 17, 2014, funded the first phase of a multi-phase project, where the remaining phases will be funded by SRF assistance in the future?

In such a case, the phases of the project will be considered a single project if all construction necessary to complete the building or work, regardless of the number of contracts or assistance agreements involved, are closely related in purpose, time and place. However, there are many situations in which major construction activities are clearly undertaken in phases that are distinct in purpose, time, or place. In the case of distinct phases, projects with engineering plans and specifications approval or assistance agreements signed prior to January 17, 2014 would be excluded from AIS requirements while those approved/signed on January 17, 2014, or later would be covered by the AIS requirements.

8) What if a project has split funding from a non-SRF source?

Many States intend to fund projects with “split” funding, from the SRF program and from State or other programs. Based on the Act language in section 436, which requires that American iron and steel products be used in any project for the construction, alteration, maintenance, or repair of a public water system or treatment works receiving SRF funding between and including January 17, 2014 and September 30, 2014, any project that is funded in whole or in part with such funds must comply with the AIS requirement. A “project” consists of all construction necessary to complete the building or work regardless of the number of contracts or assistance agreements involved so long as all contracts and assistance agreements awarded are closely related in purpose, time and place. This precludes the intentional splitting of SRF projects into separate and smaller contracts or assistance agreements to avoid AIS coverage on some portion of a larger project, particularly where the activities are integrally and proximately related to the whole. However, there are many situations in which major construction activities are clearly undertaken in separate phases that are distinct in purpose, time, or place, in which

case, separate contracts or assistance agreement for SRF and State or other funding would carry separate requirements.

9) What about refinancing?

If a project began construction, financed from a non-SRF source, prior to January 17, 2014, but is refinanced through an SRF assistance agreement executed on or after January 17, 2014 and prior to October 1, 2014, AIS requirements will apply to all construction that occurs on or after January 17, 2014, through completion of construction, unless, as is likely, engineering plans and specifications were approved by a responsible state agency prior to January 17, 2014. There is no retroactive application of the AIS requirements where a refinancing occurs for a project that has completed construction prior to January 17, 2014.

10) Do the AIS requirements apply to any other EPA programs, besides the SRF program, such as the Tribal Set-aside grants or grants to the Territories and DC?

No, the AIS requirement only applies to funds made available by a State water pollution control revolving fund as authorized by title VI of the Federal Water Pollution Control Act (33 U.S.C. 1381 et seq.) or made available by a drinking water treatment revolving loan fund as authorized by section 1452 of the Safe Drinking Water Act (42 U.S.C. 300j-12)

Covered Iron and Steel Products

11) What is an iron or steel product?

For purposes of the CWSRF and DWSRF projects that must comply with the AIS requirement, an iron or steel product is one of the following made primarily of iron or steel that is permanently incorporated into the public water system or treatment works:

- Lined or unlined pipes or fittings;
- Manhole Covers;
- Municipal Castings (defined in more detail below);
- Hydrants;
- Tanks;
- Flanges;
- Pipe clamps and restraints;
- Valves;
- Structural steel (defined in more detail below);
- Reinforced precast concrete; and
- Construction materials (defined in more detail below).

12) What does the term ‘primarily iron or steel’ mean?

‘Primarily iron or steel’ places constraints on the list of products above. For one of the listed products to be considered subject to the AIS requirements, it must be made of greater than 50% iron or steel, measured by cost. The cost should be based on the material costs.

13) Can you provide an example of how to perform a cost determination?

For example, the iron portion of a fire hydrant would likely be the bonnet, body and shoe, and the cost then would include the pouring and casting to create those components. The other material costs would include non-iron and steel internal workings of the fire hydrant (i.e., stem, coupling, valve, seals, etc). However, the assembly of the internal workings into the hydrant body would not be included in this cost calculation. If one of the listed products is not made primarily of iron or steel, United States (US) provenance is not required. An exception to this definition is reinforced precast concrete, which is addressed in a later question.

14) If a product is composed of more than 50% iron or steel, but is not listed in the above list of items, must the item be produced in the US? Alternatively, must the iron or steel in such a product be produced in the US?

The answer to both question is no. Only items on the above list must be produced in the US. Additionally, the iron or steel in a non-listed item can be sourced from outside the US.

15) What is the definition of steel?

Steel means an alloy that includes at least 50 percent iron, between .02 and 2 percent carbon, and may include other elements. Metallic elements such as chromium, nickel, molybdenum, manganese, and silicon may be added during the melting of steel for the purpose of enhancing properties such as corrosion resistance, hardness, or strength. The definition of steel covers carbon steel, alloy steel, stainless steel, tool steel and other specialty steels.

16) What does ‘produced in the United States’ mean?

Production in the United States of the iron or steel products used in the project requires that all manufacturing processes, including application of coatings, must take place in the United States, with the exception of metallurgical processes involving refinement of steel additives. All manufacturing processes includes processes such as melting, refining, forming, rolling, drawing, finishing, fabricating and coating. Further, if a domestic iron and steel product is taken out of the US for any part of the manufacturing process, it becomes foreign source material. However, raw materials such as iron ore, limestone and iron and steel scrap are not covered by the AIS requirement, and the material(s), if any, being applied as a coating are similarly not covered. Non-iron or steel components of an iron and steel product may come from non-US sources. For example, for products such as valves and hydrants, the individual non-iron and steel components

do not have to be of domestic origin.

17) Are the raw materials used in the production of iron or steel required to come from US sources?

No. Raw materials, such as iron ore, limestone, scrap iron, and scrap steel, can come from non-US sources.

18) If an above listed item is primarily made of iron or steel, but is only at the construction site temporarily, must such an item be produced in the US?

No. Only the above listed products made primarily of iron or steel, permanently incorporated into the project must be produced in the US. For example trench boxes, scaffolding or equipment, which are removed from the project site upon completion of the project, are not required to be made of U.S. Iron or Steel.

19) What is the definition of ‘municipal castings’?

Municipal castings are cast iron or steel infrastructure products that are melted and cast. They typically provide access, protection, or housing for components incorporated into utility owned drinking water, storm water, wastewater, and surface infrastructure. They are typically made of grey or ductile iron, or steel. Examples of municipal castings are:

- Access Hatches;
- Ballast Screen;
- Benches (Iron or Steel);
- Bollards;
- Cast Bases;
- Cast Iron Hinged Hatches, Square and Rectangular;
- Cast Iron Riser Rings;
- Catch Basin Inlet;
- Cleanout/Monument Boxes;
- Construction Covers and Frames;
- Curb and Corner Guards;
- Curb Openings;
- Detectable Warning Plates;
- Downspout Shoes (Boot, Inlet);
- Drainage Grates, Frames and Curb Inlets;
- Inlets;
- Junction Boxes;
- Lampposts;
- Manhole Covers, Rings and Frames, Risers;

Meter Boxes;
Service Boxes;
Steel Hinged Hatches, Square and Rectangular;
Steel Riser Rings;
Trash receptacles;
Tree Grates;
Tree Guards;
Trench Grates; and
Valve Boxes, Covers and Risers.

20) What is ‘structural steel’?

Structural steel is rolled flanged shapes, having at least one dimension of their cross-section three inches or greater, which are used in the construction of bridges, buildings, ships, railroad rolling stock, and for numerous other constructional purposes. Such shapes are designated as wide-flange shapes, standard I-beams, channels, angles, tees and zees. Other shapes include H-piles, sheet piling, tie plates, cross ties, and those for other special purposes.

21) What is a ‘construction material’ for purposes of the AIS requirement?

Construction materials are those articles, materials, or supplies made primarily of iron and steel, that are permanently incorporated into the project, not including mechanical and/or electrical components, equipment and systems. Some of these products may overlap with what is also considered “structural steel”. This includes, but is not limited to, the following products: wire rod, bar, angles, concrete reinforcing bar, wire, wire cloth, wire rope and cables, tubing, framing, joists, trusses, fasteners (i.e., nuts and bolts), welding rods, decking, grating, railings, stairs, access ramps, fire escapes, ladders, wall panels, dome structures, roofing, ductwork, surface drains, cable hanging systems, manhole steps, fencing and fence tubing, guardrails, doors, and stationary screens.

22) What is not considered a ‘construction material’ for purposes of the AIS requirement?

Mechanical and electrical components, equipment and systems are not considered construction materials. Mechanical equipment is typically that which has motorized parts and/or is powered by a motor. Electrical equipment is typically any machine powered by electricity and includes components that are part of the electrical distribution system.

The following examples (including their appurtenances necessary for their intended use and operation) are NOT considered construction materials: pumps, motors, gear reducers, drives (including variable frequency drives (VFDs)), electric/pneumatic/manual accessories used to operate valves (such as electric valve actuators), mixers, gates, motorized screens (such as traveling screens), blowers/aeration equipment, compressors, meters, sensors, controls and switches, supervisory control and data acquisition (SCADA), membrane bioreactor systems, membrane filtration systems, filters, clarifiers and clarifier mechanisms, rakes, grinders, disinfection systems, presses (including belt presses), conveyors, cranes, HVAC (excluding ductwork), water heaters,

heat exchangers, generators, cabinetry and housings (such as electrical boxes/enclosures), lighting fixtures, electrical conduit, emergency life systems, metal office furniture, shelving, laboratory equipment, analytical instrumentation, and dewatering equipment.

23) If the iron or steel is produced in the US, may other steps in the manufacturing process take place outside of the US, such as assembly?

No. Production in the US of the iron or steel used in a listed product requires that all manufacturing processes must take place in the United States, except metallurgical processes involving refinement of steel additives.

24) What processes must occur in the US to be compliant with the AIS requirement for reinforced precast concrete?

While reinforced precast concrete may not be at least 50% iron or steel, in this particular case, the reinforcing bar and wire must be produced in the US and meet the same standards as for any other iron or steel product. Additionally, the casting of the concrete product must take place in the US. The cement and other raw materials used in concrete production are not required to be of domestic origin.

If the reinforced concrete is cast at the construction site, the reinforcing bar and wire are considered to be a construction material and must be produced in the US.

Compliance

25) How should an assistance recipient document compliance with the AIS requirement?

In order to ensure compliance with the AIS requirement, specific AIS contract language must be included in each contract, starting with the assistance agreement, all the way down to the purchase agreements. Sample language for assistance agreements and contracts can be found in Appendix 3 and 4.

EPA recommends the use of a step certification process, similar to one used by the Federal Highway Administration. The step certification process is a method to ensure that producers adhere to the AIS requirement and assistance recipients can verify that products comply with the AIS requirement. The process also establishes accountability and better enables States to take enforcement actions against violators.

Step certification creates a paper trail which documents the location of the manufacturing process involved with the production of steel and iron materials. A step certification is a process under which each handler (supplier, fabricator, manufacturer,

processor, etc) of the iron and steel products certifies that their step in the process was domestically performed. Each time a step in the manufacturing process takes place, the manufacturer delivers its work along with a certification of its origin. A certification can be quite simple. Typically, it includes the name of the manufacturer, the location of the manufacturing facility where the product or process took place (not its headquarters), a description of the product or item being delivered, and a signature by a manufacturer's responsible party. Attached, as Appendix 5, are sample certifications. These certifications should be collected and maintained by assistance recipients.

Alternatively, the final manufacturer that delivers the iron or steel product to the worksite, vendor, or contractor, may provide a certification asserting that all manufacturing processes occurred in the US. While this type of certification may be acceptable, it may not provide the same degree of assurance. Additional documentation may be needed if the certification is lacking important information. Step certification is the best practice.

26) How should a State ensure assistance recipients are complying with the AIS requirement?

In order to ensure compliance with the AIS requirement, States SRF programs must include specific AIS contract language in the assistance agreement. Sample language for assistance agreements can be found in Appendix 3.

States should also, as a best practice, conduct site visits of projects during construction and review documentation demonstrating proof of compliance which the assistance recipient has gathered.

27) What happens if a State or EPA finds a non-compliant iron and/or steel product permanently incorporated in the project?

If a potentially non-compliant product is identified, the State should notify the assistance recipient of the apparent unauthorized use of the non-domestic component, including a proposed corrective action, and should be given the opportunity to reply. If unauthorized use is confirmed, the State can take one or more of the following actions: request a waiver where appropriate; require the removal of the non-domestic item; or withhold payment for all or part of the project. Only EPA can issue waivers to authorize the use of a non-domestic item. EPA may use remedies available to it under the Clean Water Act, the Safe Drinking Water Act, and 40 CFR part 31 grant regulations, in the event of a violation of a grant term and condition.

It is recommended that the State work collaboratively with EPA to determine the appropriate corrective action, especially in cases where the State is the one who identifies the item in noncompliance or there is a disagreement with the assistance recipient.

If fraud, waste, abuse, or any violation of the law is suspected, the Office of Inspector General (OIG) should be contacted immediately. The OIG can be reached at 1-888-546-8740 or OIG_Hotline@epa.gov. More information can be found at this website: <http://www.epa.gov/oig/hotline.htm>.

28) How do international trade agreements affect the implementation of the AIS requirements?

The AIS provision applies in a manner consistent with United States obligations under international agreements. Typically, these obligations only apply to direct procurement by the entities that are signatories to such agreements. In general, SRF assistance recipients are not signatories to such agreements, so these agreements have no impact on this AIS provision. In the few instances where such an agreement applies to a municipality, that municipality is under the obligation to determine its applicability and requirements and document the actions taken to comply for the State.

Waiver Process

The statute permits EPA to issue waivers for a case or category of cases where EPA finds (1) that applying these requirements would be inconsistent with the public interest; (2) iron and steel products are not produced in the US in sufficient and reasonably available quantities and of a satisfactory quality; or (3) inclusion of iron and steel products produced in the US will increase the cost of the overall project by more than 25 percent.

In order to implement the AIS requirements, EPA has developed an approach to allow for effective and efficient implementation of the waiver process to allow projects to proceed in a timely manner. The framework described below will allow States, on behalf of the assistance recipients, to apply for waivers of the AIS requirement directly to EPA Headquarters. Only waiver requests received from states will be considered. Pursuant to the Act, EPA has the responsibility to make findings as to the issuance of waivers to the AIS requirements.

Definitions

The following terms are critical to the interpretation and implementation of the AIS requirements and apply to the process described in this memorandum:

Reasonably Available Quantity: The quantity of iron or steel products is available or will be available at the time needed and place needed, and in the proper form or specification as specified in the project plans and design.

Satisfactory Quality: The quality of iron or steel products, as specified in the project plans and designs.

Assistance Recipient: A borrower or grantee that receives funding from a State CWSRF or DWSRF program.

Step-By-Step Waiver Process

Application by Assistance Recipient

Each local entity that receives SRF water infrastructure financial assistance is required by section 436 of the Act to use American made iron and steel products in the construction of its project. However, the recipient may request a waiver. Until a waiver is granted by EPA, the AIS requirement stands, except as noted above with respect to municipalities covered by international agreements.

The waiver process begins with the SRF assistance recipient. In order to fulfill the AIS requirement, the assistance recipient must in good faith design the project (where applicable) and solicit bids for construction with American made iron and steel products. It is essential that the assistance recipient include the AIS terms in any request for proposals or solicitations for bids, and in all contracts (see Appendix 3 for sample construction contract language). The assistance recipient may receive a waiver at any point before, during, or after the bid process, if one or more of three conditions is met:

1. Applying the American Iron and Steel requirements of the Act would be inconsistent with the public interest;
2. Iron and steel products are not produced in the United States in sufficient and reasonably available quantities and of a satisfactory quality; or
3. Inclusion of iron and steel products produced in the United States will increase the cost of the overall project by more than 25 percent.

Proper and sufficient documentation must be provided by the assistance recipient. A checklist detailing the types of information required for a waiver to be processed is attached as Appendix 1.

Additionally, it is strongly encouraged that assistance recipients hold pre-bid conferences with potential bidders. A pre-bid conference can help to identify iron and steel products needed to complete the project as described in the plans and specifications that may not be available from domestic sources. It may also identify the need to seek a waiver prior to bid, and can help inform the recipient on compliance options.

In order to apply for a project waiver, the assistance recipient should email the request in the form of a Word document (.doc) to the State SRF program. It is strongly recommended that the State designate a single person for all AIS communications. The State SRF designee will review the application for the waiver and determine whether the necessary information has been included. Once the waiver application is complete, the State designee will forward the application to the EPA for review.

Evaluation by EPA

After receiving an application for waiver of the AIS requirements, EPA Headquarters will publish the request on its website for 15 days and receive informal comment. EPA Headquarters will then use the checklist in Appendix 2 to determine whether the application properly and adequately documents and justifies the statutory basis cited for the waiver – that it is quantitatively and qualitatively sufficient – and to

determine whether or not to grant the waiver.

In the event that EPA finds that adequate documentation and justification has been submitted, the Administrator may grant a waiver to the assistance recipient. EPA will notify the State designee that a waiver request has been approved or denied as soon as such a decision has been made. Granting such a waiver is a three-step process:

1. Posting – After receiving an application for a waiver, EPA is required to publish the application and all material submitted with the application on EPA’s website for 15 days. During that period, the public will have the opportunity to review the request and provide informal comment to EPA. The website can be found at: http://water.epa.gov/grants_funding/aisrequirement.cfm
2. Evaluation – After receiving an application for waiver of the AIS requirements, EPA Headquarters will use the checklist in Appendix 2 to determine whether the application properly and adequately documents and justifies the statutory basis cited for the waiver – that it is quantitatively and qualitatively sufficient – and to determine whether or not to grant the waiver.
3. Signature of waiver approval by the Administrator or another agency official with delegated authority – As soon as the waiver is signed and dated, EPA will notify the State SRF program, and post the signed waiver on our website. The assistance recipient should keep a copy of the signed waiver in its project files.

Public Interest Waivers

EPA has the authority to issue public interest waivers. Evaluation of a public interest waiver request may be more complicated than that of other waiver requests so they may take more time than other waiver requests for a decision to be made. An example of a public interest waiver that might be issued could be for a community that has standardized on a particular type or manufacturer of a valve because of its performance to meet their specifications. Switching to an alternative valve may require staff to be trained on the new equipment and additional spare parts would need to be purchased and stocked, existing valves may need to be unnecessarily replaced, and portions of the system may need to be redesigned. Therefore, requiring the community to install an alternative valve would be inconsistent with public interest.

EPA also has the authority to issue a public interest waiver that covers categories of products that might apply to all projects.

EPA reserves the right to issue national waivers that may apply to particular classes of assistance recipients, particular classes of projects, or particular categories of iron or steel products. EPA may develop national or (US geographic) regional categorical waivers through the identification of similar circumstances in the detailed justifications presented to EPA in a waiver request or requests. EPA may issue a national waiver based on policy decisions regarding the public's interest or a determination that a particular item is not produced domestically in reasonably available quantities or of a sufficient quality. In such cases, EPA may determine it is necessary to issue a national waiver.

If you have any questions concerning the contents of this memorandum, you may contact us, or have your staff contact Jordan Dorfman, Attorney-Advisor, State Revolving Fund Branch, Municipal Support Division, at dorfman.jordan@epa.gov or (202) 564-0614 or Kiri Anderer, Environmental Engineer, Infrastructure Branch, Drinking Water Protection Division, at anderer.kirsten@epa.gov or (202) 564-3134.

Attachments

Appendix 1: Information Checklist for Waiver Request

The purpose of this checklist is to help ensure that all appropriate and necessary information is submitted to EPA. EPA recommends that States review this checklist carefully and provide all appropriate information to EPA. This checklist is for informational purposes only and does not need to be included as part of a waiver application.

Items	✓	Notes
<p>General</p> <ul style="list-style-type: none"> • Waiver request includes the following information: <ul style="list-style-type: none"> — Description of the foreign and domestic construction materials — Unit of measure — Quantity — Price — Time of delivery or availability — Location of the construction project — Name and address of the proposed supplier — A detailed justification for the use of foreign construction materials • Waiver request was submitted according to the instructions in the memorandum • Assistance recipient made a good faith effort to solicit bids for domestic iron and steel products, as demonstrated by language in requests for proposals, contracts, and communications with the prime contractor 	✓	
<p>Cost Waiver Requests</p> <ul style="list-style-type: none"> • Waiver request includes the following information: <ul style="list-style-type: none"> — Comparison of overall cost of project with domestic iron and steel products to overall cost of project with foreign iron and steel products — Relevant excerpts from the bid documents used by the contractors to complete the comparison — Supporting documentation indicating that the contractor made a reasonable survey of the market, such as a description of the process for identifying suppliers and a list of contacted suppliers 		
<p>Availability Waiver Requests</p> <ul style="list-style-type: none"> • Waiver request includes the following supporting documentation necessary to demonstrate the availability, quantity, and/or quality of the materials for which the waiver is requested: <ul style="list-style-type: none"> — Supplier information or pricing information from a reasonable number of domestic suppliers indicating availability/delivery date for construction materials — Documentation of the assistance recipient's efforts to find available domestic sources, such as a description of the process for identifying suppliers and a list of contacted suppliers. — Project schedule — Relevant excerpts from project plans, specifications, and permits indicating the required quantity and quality of construction materials • Waiver request includes a statement from the prime contractor and/or supplier confirming the non-availability of the domestic construction materials for which the waiver is sought • Has the State received other waiver requests for the materials described in this waiver request, for comparable projects? 		

Appendix 2: HQ Review Checklist for Waiver Request

Instructions: To be completed by EPA. Review all waiver requests using the questions in the checklist, and mark the appropriate box as Yes, No or N/A. Marks that fall inside the shaded boxes may be grounds for denying the waiver. If none of your review markings fall into a shaded box, the waiver is eligible for approval if it indicates that one or more of the following conditions applies to the domestic product for which the waiver is sought:

1. The iron and/or steel products are not produced in the United States in sufficient and reasonably available quantities and of a satisfactory quality.
2. The inclusion of iron and/or steel products produced in the United States will increase the cost of the overall project by more than 25 percent.

Review Items	Yes	No	N/A	Comments
<p>Cost Waiver Requests</p> <ul style="list-style-type: none"> • Does the waiver request include the following information? <ul style="list-style-type: none"> — Comparison of overall cost of project with domestic iron and steel products to overall cost of project with foreign iron and steel products — Relevant excerpts from the bid documents used by the contractors to complete the comparison — A sufficient number of bid documents or pricing information from domestic sources to constitute a reasonable survey of the market • Does the Total Domestic Project exceed the Total Foreign Project Cost by more than 25%? 				
<p>Availability Waiver Requests</p> <ul style="list-style-type: none"> • Does the waiver request include supporting documentation sufficient to show the availability, quantity, and/or quality of the iron and/or steel product for which the waiver is requested? <ul style="list-style-type: none"> — Supplier information or other documentation indicating availability/delivery date for materials — Project schedule — Relevant excerpts from project plans, specifications, and permits indicating the required quantity and quality of materials • Does supporting documentation provide sufficient evidence that the contractors made a reasonable effort to locate domestic suppliers of materials, such as a description of the process for identifying suppliers and a list of contacted suppliers? • Based on the materials delivery/availability date indicated in the supporting documentation, will the materials be unavailable when they are needed according to the project schedule? (By item, list schedule date and domestic delivery quote date or other relevant information) • Is EPA aware of any other evidence indicating the non-availability of the materials for which the waiver is requested? <p>Examples include:</p> <ul style="list-style-type: none"> — Multiple waiver requests for the materials described in this waiver request, for comparable projects in the same State — Multiple waiver requests for the materials described in this waiver request, for comparable projects in other States — Correspondence with construction trade associations indicating the non-availability of the materials • Are the available domestic materials indicated in the bid documents of inadequate quality compared those required by the project plans, specifications, and/or permits? 				

Appendix 5: Sample Certifications

The following information is provided as a sample letter of **step** certification for AIS compliance. Documentation must be provided on company letterhead.

Date

Company Name

Company Address

City, State Zip

Subject: American Iron and Steel Step Certification for Project (XXXXXXXXXX)

I, (company representative), certify that the (melting, bending, coating, galvanizing, cutting, etc.) process for (manufacturing or fabricating) the following products and/or materials shipped or provided for the subject project is in full compliance with the American Iron and Steel requirement as mandated in EPA's State Revolving Fund Programs.

Item, Products and/or Materials:

1. XXXX
2. XXXX
3. XXXX

Such process took place at the following location:

If any of the above compliance statements change while providing material to this project we will immediately notify the prime contractor and the engineer.

Signed by company representative

The following information is provided as a sample letter of certification for AIS compliance. Documentation must be provided on company letterhead.

Date

Company Name

Company Address

City, State Zip

Subject: American Iron and Steel Certification for Project (XXXXXXXXXXXX)

I, (company representative), certify that the following products and/or materials shipped/provided to the subject project are in full compliance with the American Iron and Steel requirement as mandated in EPA's State Revolving Fund Programs.

Item, Products and/or Materials:

1. XXXX
2. XXXX
3. XXXX

Such process took place at the following location:

If any of the above compliance statements change while providing material to this project we will immediately notify the prime contractor and the engineer.

Signed by company representative

**American Iron & Steel (AIS) Requirement of the Consolidated Appropriations Act of 2014
(Public Law 113-76)**

Q&A Part 2

PRODUCT QUESTIONS

1. Q: Do all fasteners qualify for de minimis exemption?

A: No. There is no broad exemption for fasteners from the American Iron and Steel (AIS) requirements. Significant fasteners used in SRF projects are not subject to the de minimis waiver for projects and must comply with the AIS requirements. Significant fasteners include fasteners produced to industry standards (e.g., ASTM standards) and/or project specifications, special ordered or those of high value. When bulk purchase of unknown-origin fasteners that are of incidental use and small value are used on a project, they may fall under the national de minimis waiver for projects. The list of potential items could be varied, such as big-box/hardware-store-variety screws, nails, and staples. The key characteristics of the items that may qualify for the de minimis waiver would be items that are incidental to the project purpose (such as drywall screws) and not significant in value or purpose (such as common nails or brads).

EPA also clarifies that minor components of two listed products – valves and hydrants -- may not need to meet the AIS requirements if the minor components compromise a very small quantity of minor, low-cost fasteners that are of unknown origin.

2. Q: Does PCCP pipe have to be domestically produced?

A: Yes. Pre-stressed concrete cylinder pipe (PCCP) or other similar concrete cylinder pipes would be comparable to pre-cast concrete which is specifically listed in the Consolidated Appropriations Act of 2014 as a product subject to the AIS requirement.

3. Q: If the iron or steel is made from recycled metals will the vendor/supplier have to provide a certification document certifying that the recycled metals are domestically produced?

A: No. Recycled source materials used in the production of iron and steel products do not have to come from the U.S. Iron or steel scrap, for instance, are considered raw materials that may come from anywhere. While certification is not required for the raw material, EPA does recommend that additional final processing of iron and steel be certified to have occurred in the U.S.

4. Q: Do tanks used for filtration systems, if delivered to the construction site separately and then filled with filtration media onsite, have to be domestically produced?

A: No. Tanks that are specifically designed to be filters, or as parts of a filtration system, do not have to be domestically produced because these parts are no longer simply tanks, even if the filter media has not been installed and will be installed at the project site, as is customary to do for shipping purposes. These parts have only one purpose which is to be housing for filters and cannot be used in another fashion.

5. Q: Can a recipient use non-domestic flanged pipe?

A: No. While the Consolidated Appropriations Act of 2014 does not specifically mention flanged pipe, since it does mention both pipe and flanges, both products would need to be domestically produced. Therefore, flanged pipe would also need to be domestically produced.

6. Q: Can a recipient use non-domestic couplings, expansion joints, and other similar pipe connectors?

A: No. These products would be considered specialty fittings, due to their additional functionality, but still categorized under the larger “fitting” categorization. Fittings are defined as a material that joins pipes together or connects to a pipe (AWWA, The Drinking Water Dictionary, 2000). Therefore, these products must comply with the AIS requirements and be produced domestically.

7. Q: Can a recipient use non-domestic service saddles and tapping sleeves?

A: No. These products are necessary for pipe repair, to tap a water main, or to install a service or house connection. Therefore, they are included under the larger “pipe restraint” category which is a specifically identified product subject to the domestic preference in the Consolidated Appropriations Act of 2014.

8. Q: The AIS guidance does not appear to cover reused items (i.e., existing pipe fittings, used storage tanks, reusing existing valves). How should reused items be addressed?

A: The AIS guidance does not address reuse of items. Reuse of items that would otherwise be covered by AIS is acceptable provided that the item(s) was originally purchased prior to January 17, 2014, the reused item(s) is not substantially altered from original form/function, and any restoration work that may be required does not include the replacement or addition of foreign iron or steel replacement parts. EPA recommends keeping a log of these reused items by including them on the assistance recipient’s de minimis list, and stating therein that these items are reused products. The donation of new items (such as a manufacturer waiving cost for certain delivered items because of concerns regarding the origin of a new product) is not, however, considered reuse.

9. Q: What does “time needed” mean in the AIS guidance, in reference to the definition of “Reasonably Available Quantity”?

A: For considering whether a product would meet reasonably available quantity, “time needed” is based on the construction schedule. If the item is delayed and there is substantial impact on the overall construction schedule, this would not be according to the “time needed.”

10. Q: If a product is not specifically included on the list of AIS covered products, must it comply with AIS?

A: Possibly. The AIS requirements include a list of specifically covered products, one of which is construction materials, a broad category of potential products. For construction materials, EPA’s AIS guidance includes a set of example items that it considers construction materials composed primarily of iron and steel and covered by the Act. This example list in the guidance is not an all-inclusive list of potential construction materials. However, the guidance also includes a list of items that EPA specifically does not consider construction materials, generally those of electrical or complex-mechanical nature. If a product is similar to the ones in the non-construction material list (and it is also not specifically listed by the Act), it is not a construction material. For all other items specifically included in the Act, coverage is generally self-evident.

11. Q: If a listed iron and steel product is used as a part for an assembled product that is non-domestic, do the AIS requirements apply?

A: AIS requirements only apply to the final product as delivered to the work site and incorporated into the project. Other assemblies, such as a pumping assembly or a reverse osmosis package plant, are distinct products not listed and do not need to be made in the U.S. or composed of all U.S. parts. Therefore, for the case of a non-covered product used in a larger non-domestic assembly, the components, even if specifically listed in the Consolidated Appropriations Act, do not have to be domestically produced.

12. Q: Is cast iron excluded from the AIS requirements?

A: No. Cast iron products that fall under the definition of iron and steel products must comply with the AIS requirements.

13. Q: The guidance states that “construction materials” do not include mechanical equipment, but then identifies ductwork as a construction material. Please clarify.

A: Ductwork is not mechanical equipment, therefore it is considered a “construction material” and must comply with the AIS requirements.

14. Q: Do “meters” mentioned in EPA’s guidance as non-construction materials include both flow meters and water meters?

A: Yes. “Meters” includes any type of meter, including: flow meters, wholesale meters, and water meters/service connections.

15. Q: Must coiled steel be domestic?

A: Yes. Coiled steel is an intermediate product used in the production of steel pipe and must come from a U.S. source or subject to a waiver in order to comply with the AIS requirements.

16. Q: Are pig iron, direct reduced iron (DRI), and ingot considered raw materials?

A: No. These are considered intermediate products used in the production of iron or steel and must come from a U.S. source or subject to a waiver in order to comply with the AIS requirements.

17. Q: Can assistance recipients rely on a marking that reads, “Made in the USA,” as evidence that all processes took place in the U.S.?

A: No. This designation is not consistent with our requirements that all manufacturing processes of iron and steel products must take place in the U.S.

18. Q: When determining what constitutes a product made “primarily” of iron or steel, who makes this determination?

A: The manufacturer will show if its product qualifies as primarily made of iron or steel. The recipient should expect the manufacturer to provide documentation/ certification that its product is AIS compliant.

19. Q: Do aerators need to be produced domestically in order to comply with AIS?

A: No. Aerators, similar to pumps, are mechanical equipment that do not need to meet the AIS requirements. “Blowers/aeration equipment, compressors” are listed in EPA’s guidance as non-construction materials.

20. Q: Are Sluice and Slide Gates considered valves?

A: No. Valves are products that are generally encased / enclosed with a body, bonnet, and stem. Examples include enclosed butterfly, ball, globe, piston, check, wedge, and gate valves. Furthermore, “gates” (meaning sluice, slide or weir gates) are listed in EPA’s guidance as non-construction materials.

AIS PROCESS QUESTIONS

21. Q: Will notices of waiver applications be published in the federal register?

A: No. Applications for waivers will be published on EPA’s website (http://water.epa.gov/grants_funding/aisrequirement.cfm). EPA will provide 15 days for open public comment, as noted on the website.

22. Q: Will states be collecting the step certification paper trail, as presented in the AIS guidance?

A. No. Assistance recipients must maintain documentation of compliance with AIS. EPA recommends use of the step certification process. This process is a best practice and traces all manufacturing of iron and steel products to the U.S. If the process is used, the state does not have to collect the documentation. The documents must be kept by the assistance recipient and reviewed by the state during project reviews.

23. Q: Why is it considered a best practice for states to conduct site visits, when it is the assistance recipient's responsibility to meet the AIS requirements?

A: It is both the assistance recipient's and the state's responsibility to ensure compliance with the AIS requirements. The state is the recipient of a federal grant and must comply with all grant conditions, including a condition requiring that the AIS requirements be adhered to. Therefore, it is recommended that states conduct site visits of projects during construction and review documentation demonstrating the assistance recipient's proof of compliance.

24. Q: Please further define the state's role in the waiver process.

A: The state's role in the waiver process is to review any waiver requests submitted to the state in order to ensure that all necessary information has been provided by the assistance recipient prior to forwarding the request to EPA. If a state finds the request lacking, the state should work with the assistance recipient to help obtain complete information.

25. Q: How much time does EPA have to evaluate the waiver during the evaluation step?

A: At a minimum, EPA is required to provide 15 days for open public comment. There is no specific deadline or time limit for EPA to review waiver requests. Each waiver request will come with its own specific details and circumstances and may require a different amount of time for review and analysis. For example, public interest waivers in general may take longer to review than availability waivers which are typically more straightforward. However, EPA understands that construction may be delayed while waiting for a waiver and will make every effort to review and issue decisions on waiver requests in a timely manner.

PROJECT QUESTIONS

26. Q: What if a project is funded by another funding entity (i.e., United States Department of Agriculture – Rural Development) where AIS is not required and begins construction after January 17, 2014 but then applies to the SRF to refinance the project? Are they ineligible?

A: The project is not ineligible. AIS requirements will apply to any construction that occurs after the assistance agreement is signed, through the end of construction. If construction is complete, there is no retroactive application of the AIS requirements.

27. Q: If the assistance recipient can demonstrate through market research that the AIS requirement will exceed the 25 percent cost threshold, is the entire project exempt from the AIS requirement?

A: If the waiver application shows that the inclusion of American iron and steel products causes the entire cost of the project to increase by more the 25 percent, a waiver may be granted for the entirety of the project.

28. Q: Can the recipient use non-SRF funds to pay for the non-compliant item.

A: No. It is not an acceptable to use non-SRF funds to pay for a non-compliant item. The Consolidated Appropriations Act of 2014 requires that all iron and steel products, no matter the source of funding, must be made in the U.S. if SRF funds are used in the project.

29. Q: What constitutes “satisfactory quality” as defined in the AIS guidance, in reference to the availability waiver process.

A: “Satisfactory quality” means the product meets the project design specifications. A waiver may be granted if a recipient determines that the project plans and design would be compromised because there are no American made products available that meet the project design specifications.

30. Q: The guidance states that the AIS requirement applies to any project “funded in whole or in part” by an SRF. Where is this in the Act?

A: The Act states that, “None of the funds made available by a ... [State SRF program] ... shall be used for a project for the construction, alteration, maintenance, or repair of a public water system or treatment works unless all of the iron and steel products used in the project are produced in the United States.” This sentence clearly states that no SRF program may use its funds for a project unless all of the iron and steel products used in the project are made in the U.S. This is true even if only \$1 of SRF funding is used in the project.

31. Q: There is always an expectation on the part of an assistance recipient that the construction phase of a planning and/or design only loan will be funded through the SRF. If the original planning and/or design only loan was executed prior to a January 17, 2014, does this mean the entire project will be exempt from the AIS requirement?

A: If the original loan includes construction, and was executed prior to January 17, 2014, then the AIS provision does not apply to the project. If the original loan was only for planning and/or design, then a written commitment or documented “expectation” is needed to show exemption from the

requirements. Appearance on a priority list in an Intended Use Plan along with written reasonable assurance from the state that the recipient will receive SRF funding for project construction could provide sufficient evidence of “expectation of funding”.

32. Q: What if there has been a change order or redesign requiring new plans and specifications to be approved and they were approved after January 17, 2014: does the project now have to comply with AIS?

A: In most cases, no. Change orders are typically small enough changes that the original plan and specification date will still hold true. For example, if a pipe alignment has to be changed for a block or two due to unforeseen conditions, but new plans and specifications had to be submitted for this section of the project, then that could be considered a minor change. However, if there has been a major redesign, perhaps the whole project had to be redesigned starting from scratch, then the new plans and specification approval date would apply.

33. Q: What if the bids on a project with plans and specifications approved before January 17, 2014 but the loan is signed after January 17, 2014 come in low, and there is significant funding remaining in the loan agreement, so the community designs a second project with the remaining funds: does that project have to comply with the AIS requirements?

A: If the second project is closely related in purpose, place and time to the first project, then the second project would be exempt from the AIS requirements. It is the assistance recipient’s responsibility (with state oversight) to show that a project is closely related, or not, in purpose, place and time.

34. Q: What if the assistance agreement was signed after January 17, 2014, state approval of plans for the first phase of the project was in place prior to January 17, 2014, but state approval of the plans for the second phase of the project was received after January 17, 2014?

A: In such a case, the AIS provision would not apply to the first phase of the project. If the second phase of the project is considered the same project as the first phase, due to its close relation in purpose, place and time, the entire project may be exempt. It is the assistance recipient’s responsibility (with state oversight) to show that phases of a project is closely related, or not, in purpose, place and time.

35. Q: Do products purchased through procurement-only contracts have to be comply with AIS?

A: Yes. For projects funded by SRF, the products procured under any form of contract must comply with AIS. A procurement-only contract generally involves the bulk purchase of common items (such as pipe, concrete, and/or pumps) of independent timing from a set of planned projects. If products which are purchased through a procurement-only contract are being installed under another contract, the procurement-only contract would probably not be considered a separate project in purpose, place and time; and therefore, would have to comply with the AIS requirements.

March 2015

American Iron & Steel Requirement for the Clean Water and Drinking Water State Revolving Funds

Q&A Part 3

*For CWSRF and DWSRF: On **January 17, 2014**, Public Law 113-76, the "Consolidated Appropriations Act, 2014," was enacted and included an American Iron and Steel requirement for the Clean Water and Drinking Water State Revolving Fund programs through the end of fiscal year 2014. Since then, the AIS requirement has continued for both programs, but through different statutes, with a few changes as described in the questions and answers provided below.*

*For CWSRF: On **June 10, 2014**, the Water Resources Reform and Development Act amended the Clean Water Act to include permanent requirements for the use of AIS products in CWSRF assistance agreements. Section 608 of the CWA now contains requirements for AIS that repeat those of the Consolidated Appropriations Act, 2014. All CWSRF assistance agreements must comply with Section 608 of the CWA for implementation of the permanent AIS requirement.*

*For DWSRF: On **December 16, 2014**, the President signed Public Law 113- 235, the "Consolidated and Further Continuing Appropriations Act, 2015," which provides fiscal year 2015 full-year appropriations through September 30, 2015. This law continues the requirement for the use of AIS products in DWSRF assistance agreements through September 30, 2015.*

CWSRF PROGRAM

- 1. Q: The Water Resources Reform and Development Act amended the Clean Water Act to include permanent requirements for the use of AIS for CWSRF funded assistance agreements. Does the CWA include an exemption for plans and specifications approved prior to the enactment of the legislation similar to the exemption included in the Consolidated Appropriations Act (CAA) 2014?**

A: Yes. The WRRDA amendment to the CWA, which included AIS requirements, included a similar exemption as the CAA 2014. For any CWSRF assistance agreement signed on or after October 1, 2014, if the plans and specifications were approved prior to June 10, 2014 (the enactment of WRRDA), then the project is exempt from AIS requirements. For assistance agreements signed prior to October 1, 2014, the previous dates in the CAA 2014 apply (see March 20, 2014, AIS guidance document).

If a project does not require approved engineering plans and specifications, the bid advertisement date will count in lieu of the plans and specifications approval date for purposes of this exemption in Section 608 (f).

The following table summarizes AIS exemptions based on the plans and specifications approval date for CWSRF funded projects.

3/16/2015

CWSRF AIS Project Exemption Based on Plans and Specifications Approval Date		
<u>Assistance Agreement Signed:</u>	<u>Exempt from AIS if Plans and Specifications Were Approved Before:</u>	<u>Basis for Exemption:</u>
1/17/2014 through 9/30/2014	4/15/2014	<ul style="list-style-type: none"> • Consolidated Appropriations Act 2014 • National waiver signed 4/15/2014*
On or after 10/1/2014	6/10/2014	<ul style="list-style-type: none"> • Clean Water Act Section 608

** To be covered by the national waiver, the plans and specifications had to be submitted to the state prior to 1/17/2014*

2. Q: Does the AIS requirement apply to refinanced CWSRF projects?

A: Yes, in some cases. If a project began construction, financed from a non-CWSRF source prior to June 10, 2014, but is refinanced through a CWSRF assistance agreement executed on or after October 1, 2014, AIS requirements will apply to all construction that occurs on or after June 10, 2014, through completion of construction, unless engineering plans and specifications were approved by the responsible state agency prior to June 10, 2014. For CWSRF projects funded on or after October 1, 2014, there is no retroactive application of the AIS requirements where a refinancing occurs for a project that has completed construction prior to June 10, 2014.

DWSRF PROGRAM

3. Q: The Consolidated and Further Continuing Appropriations Act 2015 continues the AIS requirements for DWSRF funded assistance agreements. Does the Act include an exemption for plans and specifications approved prior to the enactment of the legislation, similar to the exemption included in the Consolidated Appropriations Act (CAA) 2014?

A: Yes. The Consolidated and Further Continuing Appropriations Act 2015 includes a similar exemption as the CAA 2014. For any assistance agreement signed on or after December 16, 2014 (the enactment of the Act), if the plans and specifications were approved prior to December 16, 2014, then the project is exempt from the AIS requirements. For assistance agreements signed prior to December 16, 2014, the previous dates in the CAA 2014 apply (see March 20, 2014 AIS guidance document).

If a project does not require approved engineering plans and specifications, the bid advertisement date will count in lieu of the plans and specifications approval date for purposes of the exemption in Section 424(f).

3/16/2015

4. Q: Do DWSRF assistance agreements signed during the time period between September 30, 2014, and December 16, 2014, still have to comply with the AIS requirements?

A: Yes. The Continuing Appropriations Resolution 2015 was signed on September 19, 2014, which extended funding for the DWSRF with the same conditions that were made applicable by the language in the Fiscal Year 2014 appropriations, including the requirement for the use of American Iron and Steel products in projects receiving financial assistance from the DWSRF. Therefore, all assistance agreements starting October 1, 2014, through the enactment of the Consolidated and Further Continuing Appropriations Act 2015 (signed December 16, 2014), must include the AIS requirements. However, if the plans and specifications for any of these projects were approved prior to April 15, 2014 (the date the national waiver was signed), then the project is exempt from the AIS requirements.

The following table summarizes AIS exemptions based on the plans and specifications approval date for DWSRF funded projects.

DWSRF AIS Project Exemption Based on Plans and Specifications Approval Date		
<u>Assistance Agreement Signed:</u>	<u>Exempt from AIS if Plans and Specifications Were Approved Before:</u>	<u>Basis for Exemption:</u>
1/17/2014 through 9/30/2014	4/15/2014	<ul style="list-style-type: none"> • Consolidated Appropriations Act 2014 • National waiver signed 4/15/2014*
10/1/2014 through 12/15/2014	4/15/2014	<ul style="list-style-type: none"> • Continuing Appropriations Resolution 2015 (continued CAA 2014 requirements)** • National waiver signed 4/15/2014*
12/16/2014 through 9/30/2015	12/16/2014	<ul style="list-style-type: none"> • Consolidated and Further Continuing Appropriations Act 2015

* To be covered by the national waiver, the plans and specifications had to be submitted to the state prior to 1/17/2014

** Following the first continuing resolution, there were two additional CRs to fill the gap between 12/11/2014 and 12/16/2014

5. Q: Does the AIS requirement apply to refinanced DWSRF projects?

A: Yes, in some cases. If a project began construction, financed from a non-DWSRF source prior to December 16, 2014, but is refinanced through a DWSRF assistance agreement executed on or after December 16, 2014, AIS requirements will apply to all construction that occurs on or after December 16, 2014, through completion of construction, unless engineering plans and

specifications were approved by the responsible state agency prior to December 16, 2014. For DWSRF projects funded on or after December 16, 2014, there is no retroactive application of the AIS requirements where a refinancing occurs for a project that has completed construction prior to December 16, 2014.

BOTH CWSRF AND DWSRF PROGRAMS

6. **Q: If a coating is applied to the external surface of a domestic iron or steel component, and the application takes place outside of the United States, would the product be compliant under the AIS requirements?**

A: Yes. The product would still be considered a compliant product under AIS requirements. Any coating processes that are applied to the external surface of iron and steel components that would otherwise be AIS compliant would not disqualify the product from meeting the AIS requirements regardless of where the coating processes occur, provided that final assembly of the product occurs in the United States.

The exemption above only applies to coatings on the *external surface* of iron and steel components. It does not apply to coatings or linings on internal surfaces of iron and steel products, such as the lining of lined pipes. All manufacturing processes for lined pipes, including the application of pipe lining, must occur in the United States for the product to be compliant with AIS requirements.



UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

OFFICE OF WATER

DECISION MEMORANDUM

SUBJECT: De Minimis Waiver of Section 436 of P.L. 113-76, Consolidated Appropriations Act (CAA), 2014

FROM: Nancy K. Stoner
Acting Assistant Administrator

The EPA is hereby granting a nationwide waiver pursuant to the "American Iron and Steel (AIS)" requirements of P.L. 113-76, Consolidated Appropriations Act, 2014 (Act), section 436 under the authority of Section 436(b)(1) (public interest waiver) for de minimis incidental components of eligible water infrastructure projects. This action permits the use of products when they occur in de minimis incidental components of such projects funded by the Act that may otherwise be prohibited under section 436(a). Funds used for such de minimis incidental components cumulatively may comprise no more than a total of 5 percent of the total cost of the materials used in and incorporated into a project; the cost of an individual item may not exceed 1 percent of the total cost of the materials used in and incorporated into a project.

P.L. 113-76, Consolidated Appropriations Act, 2014 (Act), includes an "American Iron and Steel" (AIS) requirement in section 436 that requires Clean Water State Revolving Loan Fund (CWSRF) and Drinking Water State Revolving Loan Fund (DWSRF) assistance recipients to use specific domestic iron and steel products that are produced in the United States if the project is funded through an assistance agreement executed beginning January 17, 2014 (enactment of the Act), through the end of Fiscal Year 2014, unless the agency determines it necessary to waive this requirement based on findings set forth in Section 436(b). The Act states, "[the requirements] shall not apply in any case or category of cases in which the Administrator of the Environmental Protection Agency...finds that- (1) applying subsection (a) would be inconsistent with the public interest" 436(b)(1).

In implementing section 436 of the Act, the EPA must ensure that the section's requirements are applied consistent with congressional intent in adopting this section and in the broader context of the purposes, objectives, and other provisions applicable to projects funded under the SRF. Water infrastructure projects typically contain a relatively small number of high-cost components incorporated into the project. In bid solicitations for a project, these high-cost components are generally described in detail via project specific technical specifications. For these major components, utility owners and their contractors are generally familiar with the conditions of availability, the potential alternatives for each detailed specification, the approximate cost, and the country of manufacture of the available components.

Every water infrastructure project also involves the use of thousands of miscellaneous, generally low-cost components that are essential for, but incidental to, the construction and are incorporated into the physical structure of the project. For many of these incidental components, the country of manufacture and the availability of alternatives is not always readily or reasonably identifiable prior to procurement in the normal course of business; for other incidental components, the country of manufacture may be known but the miscellaneous character in conjunction with the low cost, individually and (in total) as typically procured in bulk, mark them as properly incidental. Examples of incidental components could include small washers, screws, fasteners (i.e., nuts and bolts), miscellaneous wire, corner bead, ancillary tube, etc. Examples of items that are clearly not incidental include significant process fittings (i.e., tees, elbows, flanges, and brackets), distribution system fittings and valves, force main valves, pipes for sewer collection and/or water distribution, treatment and storage tanks, large structural support structures, etc.

The EPA undertook multiple inquiries to identify the approximate scope of de minimis incidental components within water infrastructure projects during the implementation of the American Reinvestment and Recovery Act (ARRA) and its requirements (Buy American provisions, specifically). The inquiries and research conducted in 2009 applies suitably for the case today. In 2009, the EPA consulted informally with many major associations representing equipment manufacturers and suppliers, construction contractors, consulting engineers, and water and wastewater utilities, and performed targeted interviews with several well-established water infrastructure contractors and firms who work in a variety of project sizes, and regional and demographic settings to ask the following questions:

- What percentage of total project costs were consumables or incidental costs?
- What percentage of materials costs were consumables or incidental costs?
- Did these percentages vary by type of project (drinking water vs. wastewater treatment plant vs. pipe)?

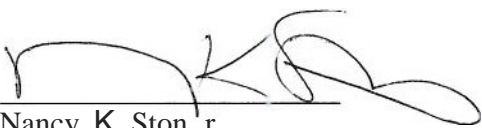
The responses were consistent across the variety of settings and project types, and indicated that the percentage of total costs for drinking water or wastewater infrastructure projects represented by these incidental components is generally not in excess of 5 percent of the total cost of the materials used in and incorporated into a project. In drafting this waiver, the EPA has considered the de minimis proportion of project costs generally represented by each individual type of these incidental components within the many types of such components comprising those percentages, the fact that these types of incidental components are obtained by contractors in many different ways from many different sources, and the disproportionate cost and delay that would be imposed on projects if the EPA did not issue this waiver.

Assistance recipients who wish to use this waiver should in consultation with their contractors determine the items to be covered by this waiver and must retain relevant documentation (i.e., invoices) as to those items in their project files.

If you have any questions concerning the contents of this memorandum, please contact Timothy Connor, Chemical Engineer, Municipal Support Division, at connor.timothy@epa.gov or (202) 566-1059 or Kirsten Anderer, Environmental Engineer, Drinking Water Protection Division, at anderer.kirsten@epa.gov or (202) 564-3134.

A?R t5 2014

Issued on: _____

Approved by: 

Nancy K. Stoner
Acting Assistant Administrator

Prohibition on Telecommunications and Video Surveillance

§ 200.216 Prohibition on certain telecommunications and video surveillance services or equipment.

- (a) Recipients and subrecipients are prohibited from obligating or expending loan or grant funds to:
 - (1) Procure or obtain;
 - (2) Extend or renew a contract to procure or obtain; or
 - (3) Enter into a contract (or extend or renew a contract) to procure or obtain equipment, services, or systems that uses covered telecommunications equipment or services as a substantial or essential component of any system, or as critical technology as part of any system. As described in [Public Law 115–232](#), section 889, covered telecommunications equipment is telecommunications equipment produced by Huawei Technologies Company or ZTE Corporation (or any subsidiary or affiliate of such entities).
 - (i) For the purpose of public safety, security of government facilities, physical security surveillance of critical infrastructure, and other national security purposes, video surveillance and telecommunications equipment produced by Hytera Communications Corporation, Hangzhou Hikvision Digital Technology Company, or Dahua Technology Company (or any subsidiary or affiliate of such entities).
 - (ii) Telecommunications or video surveillance services provided by such entities or using such equipment.
 - (iii) Telecommunications or video surveillance equipment or services produced or provided by an entity that the Secretary of Defense, in consultation with the Director of the National Intelligence or the Director of the Federal Bureau of Investigation, reasonably believes to be an entity owned or controlled by, or otherwise connected to, the government of a covered foreign country.
- (b) In implementing the prohibition under [Public Law 115–232](#), section 889, subsection (f), paragraph (1), heads of executive agencies administering loan, grant, or subsidy programs shall prioritize available funding and technical support to assist affected businesses, institutions and organizations as is reasonably necessary for those affected entities to transition from covered communications equipment and services, to procure replacement equipment and services, and to ensure that communications service to users and customers is sustained.
- (c) See [Public Law 115–232](#), section 889 for additional information.
- (d) See also [§ 200.471](#).

Resources:

[2 CRF 200.216](#)

FAQ's: [Sec. 889 of 2019 NDAA FAQ 20201124.pdf \(performance.gov\)](#)

[Public Law 115-232, Section 889](#)

[§ 200.471](#)

SECTION 8
PREVAILING WAGES

Davis-Bacon Wage Rate Requirements

(required contract provision)

Background and Applicability

On October 30, 2009, P.L. 111-88, "Making appropriations for the Department of the Interior, environment, and related agencies for the fiscal year ending September 30, 2010, and for other purposes," was enacted. This law provides appropriations for both the Clean Water State Revolving Fund (CWSRF) and the Drinking Water State Revolving Fund (DWSRF) for Fiscal Year 2010, while adding new requirements to these already existing programs. One new requirement requires the application of Davis-Bacon Act requirements.

Application of the Davis-Bacon Act requirements extend not only to assistance agreements funded with Fiscal Year 2010 appropriations, but to all assistance agreements executed on or after October 30, 2009, whether the source of the funding is prior year's appropriations, state match, bond proceeds, interest earnings, principal repayments, or any other source of funding so long as the project is financed by an SRF assistance agreement. If a project began construction prior to October 30, 2009 but is financed or refinanced through an assistance agreement executed on or after October 30, 2009, Davis-Bacon Act requirements will apply to all construction that occurs on or after October 30, 2009, through completion of construction.

Ohio EPA Responsibilities

With respect to the Water Pollution Control Loan Fund (WPCLF) and Water Supply Revolving Loan Account (WSRLA) revolving funds, EPA provides capitalization grants to each State which in turn provides funding assistance to eligible recipients within the State. Typically, the assistance recipients are municipal or other local governmental entities that manage the funds. Occasionally, the assistance recipients may be a private for profit or not for profit entity. Although EPA and the State are responsible for ensuring assistance recipients incorporate the wage rate requirements set forth herein as part of contracts for WPCLF and WSRLA funding, the assistance recipient has the primary responsibility to maintain payroll records and for compliance with Davis-Bacon Act requirements as described below.

Municipal Or Other Local Governmental Entities Recipient's Responsibilities

The following is intended to help assistance recipients understand and meet their obligations related to Davis-Bacon (DB). Each assistance recipients should, however, review the contract/subcontract requirements that are set forth later in this document for a more full understanding of DB obligations.

Prior to advertising for bids:

- > Obtain the wage determination for the locality in which a covered activity subject to DB will take place from the Department of Labor (DOL) at www.wdol.gov.
- > Incorporate these wage determinations into the request for bids.
- > Include the required contract provisions (see below) into the contract documents.
- > Require prime contracts to include provisions that subcontractors follow the wage determination incorporated into the prime contract.

During the advertisement period:

- > Monitor www.wdol.gov on a weekly basis to ensure that the wage determination contained in the request for bids remains current.
- > If DOL modifies the DB wage determination more than 10 days prior to the bid opening, issue an addendum reflecting the modification.
- > If DOL modifies or supersedes the DB wage determination less than 10 days prior to bid opening and you cannot issue an addendum for the change, you must request a finding from Ohio EPA that there is not reasonable time to notify interested contractors of the modification of the wage determination. The Ohio EPA will give you a report of its findings.

After opening bids:

- > If the contract(s) aren't awarded within 90 days of the bid opening you must monitor www.wdol.gov on a weekly basis to ensure that wage determinations used in the bids remain current.
- > If the contract(s) aren't awarded within 90 days of the bid opening, any modifications or supersedes that DOL makes to the wage determination must be incorporated into the contract unless (1) you request an extension from Ohio EPA AND (2) Ohio EPA obtains an extension of the 90 day period from DOL pursuant to 29 CFR 1.6(c)(3)(iv).

After contracts are signed and during construction:

- > Review all subcontracts subject to DB entered into by prime contractors to verify that the prime contractor has required its subcontractors to include the applicable wage determinations.
- > DOL may issue a revised wage determination applicable to one or all of your contracts after the award of the contract or execution of the change order which incorporated DB requirements into the contract if DOL determines that you have failed to incorporate a wage determination or have used a wage determination that clearly does not apply to the contract. If this occurs, you shall either terminate the contract or change order and rebid the contract OR incorporate DOL's wage determination retroactive to the beginning of the contract by change order. The contractor must be compensated for any increases in wages resulting from the use of DOL's revised wage determination.
- > Periodically interview a sufficient number of employees entitled to DB prevailing wages (covered employees) to verify that contractors or subcontractors are paying the appropriate wage rates. As provided in 29 CFR 5.6(a)(6), all interviews must be conducted in confidence. You must use Standard Form 1445 or equivalent documentation to memorialize the interviews.
- > Establish and follow an interview schedule based on its assessment of the risks of noncompliance with DB posed by contractors or subcontractors and the duration of the contract or subcontract. At a minimum, you must:
 - conduct all interviews in confidence.
 - conduct interviews with a representative group of covered employees within two weeks of each contractor or subcontractor's submission of its initial weekly payroll data and two weeks prior to the estimated completion date for the contract or subcontract.
 - conduct more frequent interviews if the initial interviews or other information indicates that there is a risk that the contractor or subcontractor is not complying with DB.
 - immediately conduct necessary interviews in response to an alleged violation of the prevailing wage requirements.
- > Periodically conduct spot checks of a representative sample of weekly payroll data to verify that contractors or subcontractors are paying the appropriate wage rates. You must:
 - establish and follow a spot check schedule based on your assessment of the risks of noncompliance with DB posed by contractors or subcontractors and the duration of the contract or subcontract.
 - spot check payroll data within two weeks of each contractor or subcontractor's submission of its initial payroll data and two weeks prior to the completion date the contract or subcontract at a minimum.
 - conduct more frequent spot checks if the initial spot check or other information indicates that there

is a risk that the contractor or subcontractor is not complying with DB.

- during the examinations, verify evidence of fringe benefit plans and payments thereunder by contractors and subcontractors who claim credit for fringe benefit contributions.

> Periodically review contractors' and subcontractors' use of apprentices and trainees to verify registration and certification with respect to apprenticeship and training programs approved by either the DOL or a state, as appropriate, and that contractors and subcontractors are not using disproportionate numbers of, laborers, trainees and apprentices. These reviews shall be conducted in accordance with the schedules for spot checks and interviews.

> Immediately report potential violations of the DB prevailing wage requirements to Andrew Lausted at EPA Region V at 312-886-0189 and to the appropriate DOL Wage and Hour District Office listed at <http://www.dol.gov/esa/contacts/whd/america2.htm>.

If contracts have already been signed and DB requirements need to be incorporated:

> If contracts have already been signed prior to WPCLF/WSRLA funding being provided, you must issue a change order, task order, work assignment or similar legally binding instrument and incorporate the appropriate DOL wage determination from www.wdol.gov as well as the required contract provisions into the contract(s).

> Initiate the contractor and subcontractor review and wage interview requirements as described above and provided in the **Contract And Subcontract Provisions**.

**Private For Profit Or Not For Profit (Non-Governmental) Entities
Recipient's Responsibilities**

The requirements, responsibilities and contract provisions for Private For Profit or Not For Profit Entities (Non-Governmental Entities) is exactly the same as for Municipal Or Other Local Governmental Entities EXCEPT for the following:

Prior to advertising for bids:

> Obtain the proposed wage determinations for specific localities from www.wdol.gov.

> Submit the wage determination to Ohio EPA for approval prior to inserting the wage determination into the solicitation unless subsequently directed otherwise by Ohio EPA.

Contract And Subcontract Provisions For Contracts In Excess Of \$2,000

The following language must be included in full in any contract in excess of \$2,000 which is entered into for the actual construction, alteration and/or repair, including painting and decorating, of a public building or public work, or building or work financed in whole or in part with WPCLF or WSRLA funds and which is subject to the labor standards provisions of any of the acts listed in §5.1:

NOTE: Modify the first sentence to include the name of the WPCLF/WSRLA funding recipient prior to including these provisions in the contract documents.

Wage Rate Requirements

As used in these provisions "subrecipient" means _____ (fill in WPCLF/WSRLA funding recipient name here).

(a) The following applies to any contract in excess of \$2,000 which is entered into for the actual construction, alteration and/or repair, including painting and decorating, of a public building or public

work, or building or work financed in whole or in part from Federal funds or in accordance with guarantees of a Federal agency or financed from funds obtained by pledge of any contract of a Federal agency to make a loan, grant or annual contribution (except where a different meaning is expressly indicated), and which is subject to the labor standards provisions of any of the acts listed in § 5.1.

(1) Minimum wages.

(i) All laborers and mechanics employed or working upon the site of the work will be paid unconditionally and not less often than once a week, and without subsequent deduction or rebate on any account (except such payroll deductions as are permitted by regulations issued by the Secretary of Labor under the Copeland Act (29 CFR part 3)), the full amount of wages and bona fide fringe benefits (or cash equivalents thereof) due at time of payment computed at rates not less than those contained in the wage determination of the Secretary of Labor which is attached hereto and made a part hereof, regardless of any contractual relationship which may be alleged to exist between the contractor and such laborers and mechanics.

Contributions made or costs reasonably anticipated for bona fide fringe benefits under section 1(b)(2) of the Davis-Bacon Act on behalf of laborers or mechanics are considered wages paid to such laborers or mechanics, subject to the provisions of paragraph (a)(1)(iv) of this section; also, regular contributions made or costs incurred for more than a weekly period (but not less often than quarterly) under plans, funds, or programs which cover the particular weekly period, are deemed to be constructively made or incurred during such weekly period. Such laborers and mechanics shall be paid the appropriate wage rate and fringe benefits on the wage determination for the classification of work actually performed, without regard to skill, except as provided in § 5.5(a)(4). Laborers or mechanics performing work in more than one classification may be compensated at the rate specified for each classification for the time actually worked therein: Provided, that the employer's payroll records accurately set forth the time spent in each classification in which work is performed. The wage determination (including any additional classification and wage rates conformed under paragraph (a)(1)(ii) of this section) and the Davis-Bacon poster (WH-1321) shall be posted at all times by the contractor and its subcontractors at the site of the work in a prominent and accessible place where it can be easily seen by the workers.

Subrecipients may obtain wage determinations from the U.S. Department of Labor's web site, www.wdol.gov.

(ii)(A) The subrecipient(s), on behalf of EPA, shall require that any class of laborers or mechanics, including helpers, which is not listed in the wage determination and which is to be employed under the contract shall be classified in conformance with the wage determination. The EPA award official shall approve an additional classification and wage rate and fringe benefits therefore only when the following criteria have been met:

(1) The work to be performed by the classification requested is not performed by a classification in the wage determination; and

(2) The classification is utilized in the area by the construction industry; and

(3) The proposed wage rate, including any bona fide fringe benefits, bears a reasonable relationship to the wage rates contained in the wage determination.

(B) If the contractor and the laborers and mechanics to be employed in the classification (if known), or their representatives, and the subrecipient(s) agree on the classification and wage rate (including the amount designated for fringe benefits where appropriate), a report of the action taken shall be sent by the subrecipient(s) to the State award official. The State award official will transmit the report, to the Administrator of the Wage and Hour Division, Employment Standards Administration, U.S. Department

of Labor, Washington, DC 20210. The Administrator, or an authorized representative, will approve, modify, or disapprove every additional classification action within 30 days of receipt and so advise the State award official or will notify the State award official within the 30-day period that additional time is necessary.

(C) In the event the contractor, the laborers or mechanics to be employed in the classification or their representatives, and the and the subrecipient(s) do not agree on the proposed classification and wage rate (including the amount designated for fringe benefits, where appropriate), the award official shall refer the questions, including the views of all interested parties and the recommendation of the State award official, to the Administrator for determination. The Administrator, or an authorized representative, will issue a determination within 30 days of receipt and so advise the contracting officer or will notify the contracting officer within the 30-day period that additional time is necessary.

(D) The wage rate (including fringe benefits where appropriate) determined pursuant to paragraphs (a)(1)(ii)(B) or (C) of this section, shall be paid to all workers performing work in the classification under this contract from the first day on which work is performed in the classification.

(iii) Whenever the minimum wage rate prescribed in the contract for a class of laborers or mechanics includes a fringe benefit which is not expressed as an hourly rate, the contractor shall either pay the benefit as stated in the wage determination or shall pay another bona fide fringe benefit or an hourly cash equivalent thereof.

(iv) If the contractor does not make payments to a trustee or other third person, the contractor may consider as part of the wages of any laborer or mechanic the amount of any costs reasonably anticipated in providing bona fide fringe benefits under a plan or program, Provided, That the Secretary of Labor has found, upon the written request of the contractor, that the applicable standards of the Davis-Bacon Act have been met. The Secretary of Labor may require the contractor to set aside in a separate account asset for the meeting of obligations under the plan or program.

(2) Withholding. The subrecipient(s), shall upon written request of the EPA Award Official or an authorized representative of the Department of Labor, withhold or cause to be withheld from the contractor under this contract or any other Federal contract with the same prime contractor, or any other federally-assisted contract subject to Davis-Bacon prevailing wage requirements, which is held by the same prime contractor, so much of the accrued payments or advances as may be considered necessary to pay laborers and mechanics, including apprentices, trainees, and helpers, employed by the contractor or any subcontractor the full amount of wages required by the contract. In the event of failure to pay any laborer or mechanic, including any apprentice, trainee, or helper, employed or working on the site of the work, all or part of the wages required by the contract, the (Agency) may, after written notice to the contractor, sponsor, applicant, or owner, take such action as may be necessary to cause the suspension of any further payment, advance, or guarantee of funds until such violations have ceased.

(3) Payrolls and basic records.

(i) Payrolls and basic records relating thereto shall be maintained by the contractor during the course of the work and preserved for a period of three years thereafter for all laborers and mechanics working at the site of the work. Such records shall contain the name, address, and social security number of each such worker, his or her correct classification, hourly rates of wages paid (including rates of contributions or costs anticipated for bona fide fringe benefits or cash equivalents thereof of the types described in section 1(b)(2)(B) of the Davis-Bacon Act), daily and weekly number of hours worked, deductions made and actual wages paid. Whenever the Secretary of Labor has found under 29 CFR 5.5(a)(1)(iv) that the wages of any laborer or mechanic include the amount of any costs reasonably anticipated in providing benefits under a plan or program described in section 1(b)(2)(B) of the Davis-Bacon Act, the contractor shall maintain records which show that the commitment to provide such benefits is enforceable, that the

plan or program is financially responsible, and that the plan or program has been communicated in writing to the laborers or mechanics affected, and records which show the costs anticipated or the actual cost incurred in providing such benefits. Contractors employing apprentices or trainees under approved programs shall maintain written evidence of the registration of apprenticeship programs and certification of trainee programs, the registration of the apprentices and trainees, and the ratios and wage rates prescribed in the applicable programs.

(ii)(A) The contractor shall submit weekly, for each week in which any contract work is performed, a copy of all payrolls to the subrecipient, that is, the entity that receives the subgrant or loan from the State capitalization grant recipient. Such documentation shall be available on request of the State recipient or EPA. As to each payroll copy received, the subrecipient shall provide written confirmation in a form satisfactory to the State indicating whether or not the project is in compliance with the requirements of 29 CFR 5.5(a)(1) based on the most recent payroll copies for the specified week. The payrolls shall set out accurately and completely all of the information required to be maintained under 29 CFR 5.5(a)(3)(i), except that full social security numbers and home addresses shall not be included on the weekly payrolls. Instead the payrolls shall only need to include an individually identifying number for each employee (e.g., the last four digits of the employee's social security number). The required weekly payroll information may be submitted in any form desired. Optional Form WH-347 is available for this purpose from the Wage and Hour Division Web site at <http://www.dol.gov/esa/whd/forms/wh347instr.htm> or its successor site. The prime contractor is responsible for the submission of copies of payrolls by all subcontractors. Contractors and subcontractors shall maintain the full social security number and current address of each covered worker, and shall provide them upon request to the subrecipient(s) for transmission to the State or EPA if requested by EPA, the State, the contractor, or the Wage and Hour Division of the Department of Labor for purposes of an investigation or audit of compliance with prevailing wage requirements. It is not a violation of this section for a prime contractor to require a subcontractor to provide addresses and social security numbers to the prime contractor for its own records, without weekly submission to the subrecipient(s).

(B) Each payroll submitted shall be accompanied by a "Statement of Compliance," signed by the contractor or subcontractor or his or her agent who pays or supervises the payment of the persons employed under the contract and shall certify the following:

(1) That the payroll for the payroll period contains the information required to be provided under § 5.5 (a)(3)(ii) of Regulations, 29 CFR part 5, the appropriate information is being maintained under § 5.5 (a)(3)(i) of Regulations, 29 CFR part 5, and that such information is correct and complete;

(2) That each laborer or mechanic (including each helper, apprentice, and trainee) employed on the contract during the payroll period has been paid the full weekly wages earned, without rebate, either directly or indirectly, and that no deductions have been made either directly or indirectly from the full wages earned, other than permissible deductions as set forth in Regulations, 29 CFR part 3;

(3) That each laborer or mechanic has been paid not less than the applicable wage rates and fringe benefits or cash equivalents for the classification of work performed, as specified in the applicable wage determination incorporated into the contract.

(C) The weekly submission of a properly executed certification set forth on the reverse side of Optional Form WH-347 shall satisfy the requirement for submission of the "Statement of Compliance" required by paragraph (a)(3)(ii)(B) of this section.

(D) The falsification of any of the above certifications may subject the contractor or subcontractor to civil or criminal prosecution under section 1001 of title 18 and section 231 of title 31 of the United States Code.

(iii) The contractor or subcontractor shall make the records required under paragraph (a)(3)(i) of this section available for inspection, copying, or transcription by authorized representatives of the State, EPA or the Department of Labor, and shall permit such representatives to interview employees during working hours on the job. If the contractor or subcontractor fails to submit the required records or to make them available, the Federal agency or State may, after written notice to the contractor, sponsor, applicant, or owner, take such action as may be necessary to cause the suspension of any further payment, advance, or guarantee of funds. Furthermore, failure to submit the required records upon request or to make such records available may be grounds for debarment action pursuant to 29 CFR 5.12.

(4) Apprentices and trainees --

(i) Apprentices. Apprentices will be permitted to work at less than the predetermined rate for the work they performed when they are employed pursuant to and individually registered in a bona fide apprenticeship program registered with the U.S. Department of Labor, Employment and Training Administration, Office of Apprenticeship Training, Employer and Labor Services, or with a State Apprenticeship Agency recognized by the Office, or if a person is employed in his or her first 90 days of probationary employment as an apprentice in such an apprenticeship program, who is not individually registered in the program, but who has been certified by the Office of Apprenticeship Training, Employer and Labor Services or a State Apprenticeship Agency (where appropriate) to be eligible for probationary employment as an apprentice. The allowable ratio of apprentices to journeymen on the job site in any craft classification shall not be greater than the ratio permitted to the contractor as to the entire work force under the registered program. Any worker listed on a payroll at an apprentice wage rate, who is not registered or otherwise employed as stated above, shall be paid not less than the applicable wage rate on the wage determination for the classification of work actually performed. In addition, any apprentice performing work on the job site in excess of the ratio permitted under the registered program shall be paid not less than the applicable wage rate on the wage determination for the work actually performed. Where a contractor is performing construction on a project in a locality other than that in which its program is registered, the ratios and wage rates (expressed in percentages of the journeyman's hourly rate) specified in the contractor's or subcontractor's registered program shall be observed. Every apprentice must be paid at not less than the rate specified in the registered program for the apprentice's level of progress, expressed as a percentage of the journeymen hourly rate specified in the applicable wage determination. Apprentices shall be paid fringe benefits in accordance with the provisions of the apprenticeship program. If the apprenticeship program does not specify fringe benefits, apprentices must be paid the full amount of fringe benefits listed on the wage determination for the applicable classification. If the Administrator determines that a different practice prevails for the applicable apprentice classification, fringes shall be paid in accordance with that determination. In the event the Office of Apprenticeship Training, Employer and Labor Services, or a State Apprenticeship Agency recognized by the Office, withdraws approval of an apprenticeship program, the contractor will no longer be permitted to utilize apprentices at less than the applicable predetermined rate for the work performed until an acceptable program is approved.

(ii) Trainees. Except as provided in 29 CFR 5.16, trainees will not be permitted to work at less than the predetermined rate for the work performed unless they are employed pursuant to and individually registered in a program which has received prior approval, evidenced by formal certification by the U.S. Department of Labor, Employment and Training Administration. The ratio of trainees to journeymen on the job site shall not be greater than permitted under the plan approved by the Employment and Training Administration. Every trainee must be paid at not less than the rate specified in the approved program for the trainee's level of progress, expressed as a percentage of the journeyman hourly rate specified in the applicable wage determination. Trainees shall be paid fringe benefits in accordance with the provisions of the trainee program. If the trainee program does not mention fringe benefits, trainees shall be paid the full amount of fringe benefits listed on the wage determination unless the Administrator of the Wage and Hour Division determines that there is an apprenticeship program associated with the corresponding journeyman wage rate on the wage determination which provides for less than full fringe

benefits for apprentices. Any employee listed on the payroll at a trainee rate who is not registered and participating in a training plan approved by the Employment and Training Administration shall be paid not less than the applicable wage rate on the wage determination for the classification of work actually performed. In addition, any trainee performing work on the job site in excess of the ratio permitted under the registered program shall be paid not less than the applicable wage rate on the wage determination for the work actually performed. In the event the Employment and Training Administration withdraws approval of a training program, the contractor will no longer be permitted to utilize trainees at less than the applicable predetermined rate for the work performed until an acceptable program is approved.

(iii) Equal employment opportunity. The utilization of apprentices, trainees and journeymen under this part shall be in conformity with the equal employment opportunity requirements of Executive Order 11246, as amended, and 29 CFR part 30.

(5) Compliance with Copeland Act requirements. The contractor shall comply with the requirements of 29 CFR part 3, which are incorporated by reference in this contract.

(6) Subcontracts. The contractor or subcontractor shall insert in any subcontracts the clauses contained in 29 CFR 5.5(a)(1) through (10) and such other clauses as the EPA determines may be appropriate, and also a clause requiring the subcontractors to include these clauses in any lower tier subcontracts. The prime contractor shall be responsible for the compliance by any subcontractor or lower tier subcontractor with all the contract clauses in 29 CFR 5.5.

(7) Contract termination: debarment. A breach of the contract clauses in 29 CFR 5.5 may be grounds for termination of the contract, and for debarment as a contractor and a subcontractor as provided in 29 CFR 5.12.

(8) Compliance with Davis-Bacon and Related Act requirements. All rulings and interpretations of the Davis-Bacon and Related Acts contained in 29 CFR parts 1, 3, and 5 are herein incorporated by reference in this contract.

(9) Disputes concerning labor standards. Disputes arising out of the labor standards provisions of this contract shall not be subject to the general disputes clause of this contract. Such disputes shall be resolved in accordance with the procedures of the Department of Labor set forth in 29 CFR parts 5, 6, and 7. Disputes within the meaning of this clause include disputes between the contractor (or any of its subcontractors) and subrecipient(s), State, EPA, the U.S. Department of Labor, or the employees or their representatives.

(10) Certification of eligibility.

(i) By entering into this contract, the contractor certifies that neither it (nor he or she) nor any person or firm who has an interest in the contractor's firm is a person or firm ineligible to be awarded Government contracts by virtue of section 3(a) of the Davis-Bacon Act or 29 CFR 5.12(a)(1).

(ii) No part of this contract shall be subcontracted to any person or firm ineligible for award of a Government contract by virtue of section 3(a) of the Davis-Bacon Act or 29 CFR 5.12(a)(1).

(iii) The penalty for making false statements is prescribed in the U.S. Criminal Code, 18 U.S.C. 1001.

Contract Provision For Contracts In Excess Of \$100,000 And Subject To The Overtime Provisions Of The Contract Work Hours And Safety Standards Act

The following language must be included in full in any contract in an amount in excess of \$100,000 and subject to the overtime provisions of the Contract Work Hours and Safety Standards Act. These provisions are to be included in addition to the provisions for contracts in excess of \$2,000. As used in these paragraphs, the terms laborers and mechanics include watchmen and guards.

(b) Contract Work Hours and Safety Standards Act. The following applies to any contract in an amount in excess of \$100,000 and subject to the overtime provisions of the Contract Work Hours and Safety Standards Act. As used in these paragraphs, the terms laborers and mechanics include watchmen and guards.

(1) Overtime requirements. No contractor or subcontractor contracting for any part of the contract work which may require or involve the employment of laborers or mechanics shall require or permit any such laborer or mechanic in any workweek in which he or she is employed on such work to work in excess of forty hours in such workweek unless such laborer or mechanic receives compensation at a rate not less than one and one-half times the basic rate of pay for all hours worked in excess of forty hours in such workweek.

(2) Violation; liability for unpaid wages; liquidated damages. In the event of any violation of the clause set forth in paragraph (b)(1) of this section the contractor and any subcontractor responsible therefore shall be liable for the unpaid wages. In addition, such contractor and subcontractor shall be liable to the United States (in the case of work done under contract for the District of Columbia or a territory, to such District or to such territory), for liquidated damages. Such liquidated damages shall be computed with respect to each individual laborer or mechanic, including watchmen and guards, employed in violation of the clause set forth in paragraph (a)(1) of this section, in the sum of \$10 for each calendar day on which such individual was required or permitted to work in excess of the standard workweek of forty hours without payment of the overtime wages required by the clause set forth in paragraph (b)(1) of this section.

(3) Withholding for unpaid wages and liquidated damages. The subrecipient, upon written request of the EPA Award Official or an authorized representative of the Department of Labor, shall withhold or cause to be withheld, from any moneys payable on account of work performed by the contractor or subcontractor under any such contract or any other Federal contract with the same prime contractor, or any other federally-assisted contract subject to the Contract Work Hours and Safety Standards Act, which is held by the same prime contractor, such sums as may be determined to be necessary to satisfy any liabilities of such contractor or subcontractor for unpaid wages and liquidated damages as provided in the clause set forth in paragraph (b)(2) of this section.

(4) Subcontracts. The contractor or subcontractor shall insert in any subcontracts the clauses set forth in paragraph (b)(1) through (4) of this section and also a clause requiring the subcontractors to include these clauses in any lower tier subcontracts. The prime contractor shall be responsible for compliance by any subcontractor or lower tier subcontractor with the clauses set forth in paragraphs (b)(1) through (4) of this section.

Contract Provision For Contracts In Excess Of \$100,000 Subject ONLY To The Contract Work Hours And Safety Standards Act

In addition to the provisions for contracts in excess of \$2,000, for any contract subject only to the Contract Work Hours and Safety Standards Act and not to any of the other statutes cited in 29 CFR 5.1, you must insert clauses requiring:

(c) The following applies to any contract subject only to the Contract Work Hours and Safety Standards Act and not to any of the other statutes cited in 29 CFR 5.1.

The contractor or subcontractor shall maintain payrolls and basic payroll records during the course of the work and shall preserve them for a period of three years from the completion of the contract for all laborers and mechanics, including guards and watchmen, working on the contract. Such records shall contain the name and address of each such employee, social security number, correct classifications, hourly rates of wages paid, daily and weekly number of hours worked, deductions made, and actual wages paid.

The records shall be maintained under this paragraph shall be made available by the contractor or subcontractor for inspection, copying, or transcription by authorized representatives of the Ohio EPA, EPA and the Department of Labor, and the contractor or subcontractor will permit such representatives to interview employees during working hours on the job.

List each worker's name.

Only laborers and mechanics performing construction work under the contract should be listed.

Please note: Business Owners need only include their name, work classification including "owner" and the daily total hours worked.

List hourly wage rate and fringes paid in cash (not those paid to plans)

Specify the job classification located in the contract wage decision and/or the corresponding job title.

Specify the net amount paid to the employee for the pay

Specify the total overtime and straight time hours worked on the project.

Specify the gross earnings for the hours worked under the contract.

(For Contractors' Optional Use) See instructions at www.doi.gov/esa/whd/forms/wh347instr.htm

Persons are not required to respond to the collection of information unless it displays a currently valid OMB control number.

NAME AND INDIVIDUAL IDENTIFYING NUMBER (6, 9, LAST FOUR DIGITS OF SOCIAL SECURITY NUMBER OF WORKER)	WORK CLASSIFICATION	(4) DAY AND DATE							TOTAL HOURS	RATE OF PAY	GROSS AMOUNT EARNED	(8) DEDUCTIONS			TOTAL DEDUCTIONS	NET WAGES PAID FOR WEEK
		Sun	Mon	Tue	Wed	Thurs	Frid	Sat				FICA	W/TH	OTHER		
Alex Driver - ####	Power Equipment Operator Bull Dozer Group 2							2.00	\$62.83	\$1,422.84	\$161.00			\$538.43	\$1,374.03	
Jason Worker - ####	General Laborer							4.00	\$45.20	\$1,702.78	\$136.06			\$47.71	\$1,233.07	
Steve Worker - ####	Carpenter							1.50	\$60.19	\$1,064.72	\$111.00	\$54.27	\$47.19	\$47.19	\$1,406.18	
Roy Wrench - ####	Apprentice Carpenter 1st 6 mo. at 40%							40.00	\$32.72	\$1,887.49	\$85.18	\$105.41	\$26.62	\$307.71	\$757.01	
Bart Turner - ####	Plumber							40.00	\$121.44	\$1,064.72	\$85.18	\$105.41	\$26.62	\$307.71	\$757.01	
Roy Wrench - ####	Plumber							20.00	\$67.88	\$1,004.80	\$163.46	\$147.11	\$51.08	\$480.16	\$1,563.04	
Bart Turner - ####	Steamfitter							20.00	\$69.13	\$1,038.40	\$163.46	\$147.11	\$51.08	\$480.16	\$1,563.04	
Bart Turner - ####	Power Equipment Operator Rotary Drill Group 4							24.00	\$34.41	\$2,043.20	\$179.28	\$142.48	\$35.98	\$415.93	\$1,023.27	

While completion of Form WH-347 is optional, it is mandatory for covered contractors and subcontractors performing work on Federally financed or assisted construction contracts to respond to (40 U.S.C. § 3145) contractors and subcontractors performing work on Federally financed or assisted construction contracts to furnish weekly a statement with respect to the wages paid each worker on the project. Contractors and subcontractors performing work on Federally financed or assisted construction contracts to furnish weekly a statement with respect to the wages paid each worker on the project. Contractors and subcontractors performing work on Federally financed or assisted construction contracts to furnish weekly a statement with respect to the wages paid each worker on the project. Contractors and subcontractors performing work on Federally financed or assisted construction contracts to furnish weekly a statement with respect to the wages paid each worker on the project.

Public Burden Statement

If part of a worker's weekly wage was earned on projects other than the project described on this payroll, enter the gross amount earned on this contract in the top half of column 7. Enter the gross amount earned during the week for all projects in the bottom half.

Alex Driver worked 29.5 hours on this contract and 12.5 hours on another contract. The gross wages earned on this project, \$1,422.84, is entered in the top half of column 7. The gross wages earned on all projects, \$2,012.46, is entered in the

(1) NAME AND INDIVIDUAL IDENTIFYING NUMBER (e.g., LAST FOUR DIGITS OF SOCIAL SECURITY NUMBER OF WORKER)	(2) JOB IDENTIFYING NUMBER	(3) WORK CLASSIFICATION	(4) DAY AND DATE							TOTAL HOURS	RATE OF PAY	GROSS AMOUNT EARNED	DEDUCTIONS				NET WAGES PAID FOR WEEK		
			HOURS WORKED EACH DAY										FICA	WITH- HOLDING TAX	State with- holding tax	Medicare		OTHER	TOTAL DEDUCTIONS
			Sun	Mon	Tue	Wed	Thur	Fri	Sat										
Alex Driver - ####	2	Power Equipment Bull Dozer Group 2							2.00	\$62.83	\$1,422.84	\$61.00	\$156.97	\$50.31	\$85.00	\$638.43	\$1,374.03		
Jason Worker - ####	2	General Laborer							4.00	\$40.70	\$2,012.46	\$35.06	\$132.66	\$42.52	\$467.71	\$1,233.07			
Sharon Wood - ####	3	Carpenter							1.50	\$60.19	\$1,700.78	\$151.00	\$154.77	\$47.19	\$481.31	\$1,406.18			
Reggie Tree - ####	1	Apprentice Carpenter 1st 6 mo. at 40%							40.00	\$32.72	\$1,064.72	\$85.18	\$105.41	\$90.50	\$307.71	\$757.01			
Roy Wrench - ####	5	Plumber							20.00	\$67.88	\$1,004.80	\$163.46	\$147.11	\$118.51	\$480.16	\$1,563.04			
Roy Wrench - ####	5	Steamfitter							20.00	\$69.13	\$1,038.40	\$115.41	\$142.48	\$35.98	\$415.53	\$1,023.27			
Bart Turner - ####	1	Power Equipment Rotary Drill Group 4							24.00	\$60.80	\$719.28	\$115.41	\$142.48	\$35.98	\$415.53	\$1,023.27			

If an employee performs multiple work classifications under the contract, use two or more lines to distinguish the different job classifications, hours worked, and hourly wage earned for each.

Combine the two classifications when recording the gross amount earned for this pay period, deductions, and net wages.

A registered apprentice performing work under a contract must be reported. The payroll must include the current pay scale & provide a copy of the apprenticeship agreement.

Provide explanation of "other" deductions on signatory page.

PAYROLL

Optional Use; See instructions at www.dol.gov/esa/whd/forms/wh347 to respond to the collection of information unless it displays a currently valid OMB control number.



ADDRESS 385 West Drive, Madison WI 53703
 PROJECT OR CONTRACT NO. 3000

PROJECT AND LOCATION
 Robin Street Apartments, Delafield WI 53018

(1) NAME AND INDIVIDUAL IDENTIFYING NUMBER (e.g., LAST FOUR DIGITS OF SOCIAL SECURITY NUMBER OF WORKER)	(2) WORK CLASSIFICATION	(4) DAY AND DATE							(5) TOTAL HOURS	(6) RATE OF PAY	(7) GROSS AMOUNT EARNED	(8) DEDUCTIONS			(9) NET WAGES PAID FOR WEEK
		Sun	Mon	Tue	Wed	Thu	Fri	Sat				FICA	WITH- HOLDING TAX	State with Holding Tax	
Alex Driver - #####	Power Equipment Bull Dozer Group 2							2.00	\$62.83	\$1,422.84	\$161.00	\$156.97	\$50.31	\$85.00	\$1,374.03
Jason Worker - #####	General Laborer							4.00	\$49.20	\$1,700.78	\$136.06	\$132.66	\$42.52		\$1,233.07
Sharon Wood - #####	Carpenter							40.00	\$60.19	\$1,887.49	\$151.00	\$128.35	\$47.19	\$481.31	\$1,406.18
Reggie Tree - #####	Apprentice Carpenter 1st 6 mo. at 40%							40.00	\$32.72	\$1,064.72	\$85.18	\$90.50	\$26.62		\$737.01
Roy Wrench - #####	Plumber							20.00	\$67.88	\$1,004.80	\$163.46	\$118.51	\$51.08	\$480.16	\$1,563.04
Roy Wrench - #####	Stearnfitter							20.00	\$69.13	\$1,038.40	\$115.14	\$122.33	\$35.98	\$415.93	\$1,023.27
Bart Turner - #####	Power Equipment Rotary Drill Group 4							24.00	\$60.80	\$1,459.20	\$115.14	\$142.48	\$35.98		\$1,023.27

While completion of Form WH-347 is required for all federal construction contracts to respond to the information collection contained in 29 C.F.R. §§ 3.3, 5.5(a), The Copeland Act (40 U.S.C. § 3145), contractor or subcontractor must file a weekly statement with respect to the wages paid each employee during the preceding week. U.S. Department of Labor (DOL) regulations at 29 C.F.R. § 5.5(a)(3)(i) require that the contractor or subcontractor file a signed "Statement of Compliance" indicating that the payrolls are correct and complete and that each laborer or mechanic has been paid in full for the preceding week. Federal contracting agencies receiving this information review the information to determine that employees have received legally required wages and fringe benefits.

Burden Statement
 We estimate that it will take approximately 15 minutes, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information, if you have any comments regarding this collection of information, including suggestions for reducing this burden, send them to the Administrator, Wage and Hour Division, ESA, U.S. Department of Labor, Room S3502, 200 Constitution Avenue, N.W., Washington, D.C. 20210

(over)

CONTRACTOR FRINGE BENEFIT STATEMENT

Contract # /Project Name:	Contract Location:	Today's Date:
Contractor / Subcontractor Name:		Business Address:

In order that the proper Fringe Benefit rates can be verified when checking payrolls on the above contract, the hourly rates for fringe benefits, subsistence and/or travel allowance payment made for employees by the employer on the various classes of work are tabulated below. **Please Include Apprentice Rates.**

	Classification:	Effective Date:	Subsistence or Travel Pay: \$ _____
EMPLOYER PAID FRINGE BENEFITS	Health & Welfare \$ _____ hr	Paid To: Name of Plan/Fund/Program: _____ Address: _____	_____
	Pension \$ _____ hr	Paid To: Name of Plan/Fund/Program: _____ Address: _____	_____
	Vacation/Holiday \$ _____ hr	Paid To: Name of Plan/Fund/Program: _____ Address: _____	_____
	Training \$ _____ hr	Paid To: Name of Plan/Fund/Program: _____ Address: _____	_____
	Other \$ _____ hr	Paid To: Name of Plan/Fund/Program: _____ Address: _____	_____

	Classification:	Effective Date:	Subsistence or Travel Pay: \$ _____
EMPLOYER PAID FRINGE BENEFITS	Health & Welfare \$ _____ hr	Paid To: Name of Plan/Fund/Program: _____ Address: _____	_____
	Pension \$ _____ hr	Paid To: Name of Plan/Fund/Program: _____ Address: _____	_____
	Vacation/Holiday \$ _____ hr	Paid To: Name of Plan/Fund/Program: _____ Address: _____	_____
	Training \$ _____ hr	Paid To: Name of Plan/Fund/Program: _____ Address: _____	_____
	Other \$ _____ hr	Paid To: Name of Plan/Fund/Program: _____ Address: _____	_____

Supplemental statements must be submitted during the progress of the work should there be an increase or change in rates. Use additional sheets as necessary. (Attach a copy of your most recent premium transmittal (including copy of check submitted) into each of the above plans/funds/programs or a letter from the above plans/funds/programs reflecting current payment status).

I certify under penalty of perjury that fringe benefits are paid to the approved plans, funds or programs as listed above.

Name and Title	Signature and Date (Wet Signature Required)
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PREVAILING WAGE NOTIFICATION TO EMPLOYEE

Project Name:		Job Number:	
Contractor:			
Project Location:			
Jobsite posting of prevailing wage rates located:			
Prevailing Wage Coordinator		Employee	
Name:		Name:	
Street:		Street:	
City:		City:	
State / Zip:		State / Zip:	
Phone:		Phone:	
<p>You will be performing work on this project that falls under these classifications. You will be paid the appropriate rate for the type of work you are performing.</p>			
Classification	Prevailing Wage Rate Total Package	Minus Your Fringe Benefits	Your Hourly Base Rate
Hourly fringe benefits paid on your behalf by this company.			
Fringe	Amount	Fringe	Amount
Health Insurance		Vacation	
Life Insurance		Holiday	
Pension		Sick Pay	
Bonus		Training	
Other		TOTAL HOURLY FRINGES	
Contractor's Signature:		Date:	
Employee's Signature:		Date:	

Wage Determinations are issued for four types of construction categories:

Heavy Construction includes projects that cannot be classified as Building, Residential, or Highway. Heavy construction is often further distinguished on the basis of the characteristic of particular projects, such as dredging, water and sewer lines, dams, major bridges, and flood control projects.

Highway Construction includes the construction, alteration, or repair of roads, streets, highways, runways, parking areas and most other paving work not incidental to building, residential, or heavy construction.

Heavy and Highway are grouped together as one State Wide Determination in Ohio.

Building Construction includes the construction, alteration, or repair of sheltered enclosures with walk-in access for the purpose of housing persons, machinery, equipment, or supplies and the associated installation of utilities and equipment, as well as incidental grading and paving.

Residential Construction includes the construction, alteration, or repair of single family houses, townhouses, and apartment buildings of no more than four stories in height and all incidental work, such as site work, parking areas, utilities, streets, and sidewalks.

***This project includes Wage Determinations for both
Building and Heavy/Highway.***

"General Decision Number: OH20240075 11/08/2024

Superseded General Decision Number: OH20230075

State: Ohio

Construction Type: Building

County: Delaware County in Ohio.

BUILDING CONSTRUCTION PROJECTS (does not include single family homes or apartments up to and including 4 stories).

Note: Contracts subject to the Davis-Bacon Act are generally required to pay at least the applicable minimum wage rate required under Executive Order 14026 or Executive Order 13658. Please note that these Executive Orders apply to covered contracts entered into by the federal government that are subject to the Davis-Bacon Act itself, but do not apply to contracts subject only to the Davis-Bacon Related Acts, including those set forth at 29 CFR 5.1(a)(1).

<p>If the contract is entered into on or after January 30, 2022, or the contract is renewed or extended (e.g., an option is exercised) on or after January 30, 2022:</p>	<p>. Executive Order 14026 generally applies to the contract. . The contractor must pay all covered workers at least \$17.20 per hour (or the applicable wage rate listed on this wage determination, if it is higher) for all hours spent performing on the contract in 2024.</p>
<p>If the contract was awarded on or between January 1, 2015 and January 29, 2022, and the contract is not renewed or extended on or after January 30, 2022:</p>	<p>. Executive Order 13658 generally applies to the contract. . The contractor must pay all covered workers at least \$12.90 per hour (or the applicable wage rate listed on this wage determination, if it is higher) for all hours spent performing on that contract in 2024.</p>

The applicable Executive Order minimum wage rate will be adjusted annually. If this contract is covered by one of the Executive Orders and a classification considered necessary for performance of work on the contract does not appear on this wage determination, the contractor must still submit a conformance request.

Additional information on contractor requirements and worker protections under the Executive Orders is available at <http://www.dol.gov/whd/govcontracts>.

Modification Number	Publication Date
0	01/05/2024
1	03/08/2024
2	04/05/2024
3	07/05/2024

4 09/06/2024
5 11/08/2024

ASBE0008-010 03/01/2024

	Rates	Fringes
ASBESTOS WORKER/HEAT & FROST INSULATOR.....	\$ 34.23	21.94

BROH0055-006 06/01/2023

	Rates	Fringes
BRICKLAYER.....	\$ 33.24	19.62

BROH0055-007 06/01/2023

	Rates	Fringes
TILE FINISHER.....	\$ 28.31	10.45
TILE SETTER.....	\$ 29.92	16.77

CARP0200-003 05/01/2024

	Rates	Fringes
CARPENTER (Soft Floor Layer and Floor Laying - Hardwood Floors Only).....	\$ 32.60	22.20

ELEC0038-004 04/24/2023

	Rates	Fringes
ELECTRICIAN (HVAC/Temperature Controls Installation Only).....	\$ 43.13	23.31

FOOTNOTES;

- a. 6 Paid Holidays: New Year's Day; Memorial Day; July 4th; Labor Day; Thanksgiving Day; & Christmas Day
- b. 1 week's paid vacation for 1 year's service; 2 weeks' paid vacation for 2 or more years' service

* ELEC0683-004 05/27/2024

	Rates	Fringes
ELECTRICIAN (Low Voltage Wiring Only).....	\$ 40.50	25.20

* ELEC0683-007 05/27/2024

	Rates	Fringes
ELECTRICIAN (Excludes Installation of HVAC/Temperature Controls and Low Voltage Wiring).....	\$ 40.50	25.20

ELEV0037-003 01/01/2024

	Rates	Fringes
ELEVATOR MECHANIC.....	\$ 54.93	37.885+a+b

PAID HOLIDAYS:

a. New Year's Day, Memorial Day, Independence Day, Labor Day, Veterans Day, Thanksgiving Day, the Friday after Thanksgiving, and Christmas Day.

b. Employer contributes 8% of regular hourly rate to vacation pay credit for employee who has worked in business more than 5 years; 6% for less than 5 years' service.

 ENGI0018-041 05/01/2024

	Rates	Fringes
POWER EQUIPMENT OPERATOR		
Bobcat/Skid Steer/Skid		
Loader; Concrete Pump;		
Crane.....	\$ 44.14	16.41
Bulldozer.....	\$ 44.02	16.41
Oiler.....	\$ 36.34	16.41

 ENGI0066-048 06/01/2017

	Rates	Fringes
POWER EQUIPMENT OPERATOR		
Grader/Blade.....	\$ 32.42	19.66
Mechanic.....	\$ 32.92	19.66

 IRON0172-005 06/01/2024

	Rates	Fringes
IRONWORKER, REINFORCING.....	\$ 36.77	22.85

 IRON0550-009 05/01/2024

	Rates	Fringes
IRONWORKER, ORNAMENTAL.....	\$ 34.70	22.88

 LABO0423-003 06/01/2023

	Rates	Fringes
LABORER		
Mason Tender - Brick &		
Cement/Concrete.....	\$ 30.59	12.65

 PAIN1275-001 05/01/2024

	Rates	Fringes
PAINTER (Spray).....	\$ 29.70	14.91

 PLUM0189-005 06/01/2024

	Rates	Fringes
PIPEFITTER.....	\$ 43.25	26.94

 SFOH0669-009 01/01/2024

	Rates	Fringes
SPRINKLER FITTER (Fire		

Sprinklers).....\$ 43.08 27.49

SHEE0024-028 06/01/2022

Rates Fringes

SHEET METAL WORKER (Excludes HVAC Duct and Unit Installation).....\$ 33.53 26.36

* SUOH2012-077 08/29/2014

Rates Fringes

ABATEMENT WORKER: ASBESTOS (Removal from Ceilings, Floors, and Walls).....\$ 22.74 9.25

CARPENTER (Acoustical Ceiling Installation Only).....\$ 24.17 8.61

CARPENTER (Excluding Floor Laying - Hard Wood Floors, Soft Floor Laying, and Acoustical Ceiling Installation).....\$ 28.52 8.59

CEMENT MASON/CONCRETE FINISHER...\$ 26.07 12.34

DRYWALL FINISHER/TAPER.....\$ 20.44 4.75

DRYWALL HANGER AND METAL STUD INSTALLER.....\$ 21.15 3.75

GLAZIER.....\$ 22.60 11.02

IRONWORKER, STRUCTURAL.....\$ 26.52 16.23

LABORER: Common or General.....\$ 29.24 5.17

LABORER: Landscape & Irrigation.....\$ 13.74 ** 0.00

LABORER: Pipelayer.....\$ 23.98 8.58

OPERATOR: Backhoe/Excavator/Trackhoe.....\$ 27.26 9.80

OPERATOR: Forklift.....\$ 22.79 12.76

OPERATOR: Loader.....\$ 29.66 12.61

OPERATOR: Paver (Asphalt, Aggregate, and Concrete).....\$ 30.28 13.29

OPERATOR: Roller.....\$ 28.83 12.72

PAINTER (Brush and Roller).....\$ 24.97 0.00

PLUMBER.....\$ 25.28 6.87

ROOFER.....\$ 25.24 11.38

SHEET METAL WORKER (HVAC Duct and HVAC Unit Installation Only).....\$ 26.26 15.77

TRUCK DRIVER: Dump (All Types)...\$ 24.32 11.73

WELDERS - Receive rate prescribed for craft performing operation to which welding is incidental.

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** Workers in this classification may be entitled to a higher minimum wage under Executive Order 14026 (\$17.20) or 13658 (\$12.90). Please see the Note at the top of the wage determination for more information. Please also note that the minimum wage requirements of Executive Order 14026 are not currently being enforced as to any contract or subcontract to which the states of Texas, Louisiana, or Mississippi, including their agencies, are a party.

Note: Executive Order (EO) 13706, Establishing Paid Sick Leave for Federal Contractors applies to all contracts subject to the Davis-Bacon Act for which the contract is awarded (and any solicitation was issued) on or after January 1, 2017. If this contract is covered by the EO, the contractor must provide employees with 1 hour of paid sick leave for every 30 hours they work, up to 56 hours of paid sick leave each year. Employees must be permitted to use paid sick leave for their own illness, injury or other health-related needs, including preventive care; to assist a family member (or person who is like family to the employee) who is ill, injured, or has other health-related needs, including preventive care; or for reasons resulting from, or to assist a family member (or person who is like family to the employee) who is a victim of, domestic violence, sexual assault, or stalking. Additional information on contractor requirements and worker protections under the EO is available at <https://www.dol.gov/agencies/whd/government-contracts>.

Unlisted classifications needed for work not included within the scope of the classifications listed may be added after award only as provided in the labor standards contract clauses (29CFR 5.5 (a) (1) (iii)).

The body of each wage determination lists the classification and wage rates that have been found to be prevailing for the cited type(s) of construction in the area covered by the wage determination. The classifications are listed in alphabetical order of ""identifiers"" that indicate whether the particular rate is a union rate (current union negotiated rate for local), a survey rate (weighted average rate) or a union average rate (weighted union average rate).

Union Rate Identifiers

A four letter classification abbreviation identifier enclosed in dotted lines beginning with characters other than ""SU"" or ""UAVG"" denotes that the union classification and rate were prevailing for that classification in the survey. Example: PLUM0198-005 07/01/2014. PLUM is an abbreviation identifier of the union which prevailed in the survey for this classification, which in this example would be Plumbers. 0198 indicates the local union number or district council number where applicable, i.e., Plumbers Local 0198. The next number, 005 in the example, is an internal number used in processing the wage determination. 07/01/2014 is the effective date of the

most current negotiated rate, which in this example is July 1, 2014.

Union prevailing wage rates are updated to reflect all rate changes in the collective bargaining agreement (CBA) governing this classification and rate.

Survey Rate Identifiers

Classifications listed under the ""SU"" identifier indicate that no one rate prevailed for this classification in the survey and the published rate is derived by computing a weighted average rate based on all the rates reported in the survey for that classification. As this weighted average rate includes all rates reported in the survey, it may include both union and non-union rates. Example: SULA2012-007 5/13/2014. SU indicates the rates are survey rates based on a weighted average calculation of rates and are not majority rates. LA indicates the State of Louisiana. 2012 is the year of survey on which these classifications and rates are based. The next number, 007 in the example, is an internal number used in producing the wage determination. 5/13/2014 indicates the survey completion date for the classifications and rates under that identifier.

Survey wage rates are not updated and remain in effect until a new survey is conducted.

Union Average Rate Identifiers

Classification(s) listed under the UAVG identifier indicate that no single majority rate prevailed for those classifications; however, 100% of the data reported for the classifications was union data. EXAMPLE: UAVG-OH-0010 08/29/2014. UAVG indicates that the rate is a weighted union average rate. OH indicates the state. The next number, 0010 in the example, is an internal number used in producing the wage determination. 08/29/2014 indicates the survey completion date for the classifications and rates under that identifier.

A UAVG rate will be updated once a year, usually in January of each year, to reflect a weighted average of the current negotiated/CBA rate of the union locals from which the rate is based.

State Adopted Rate Identifiers

Classifications listed under the ""SA"" identifier indicate that the prevailing wage rate set by a state (or local) government was adopted under 29 C.F.R. 1.3(g)-(h). Example: SAME2023-007 01/03/2024. SA reflects that the rates are state adopted. ME refers to the State of Maine. 2023 is the year during which the state completed the survey on which the listed classifications and rates are based. The next number, 007 in the example, is an internal number used in producing the wage determination. 01/03/2024 reflects the date on which the classifications and rates under the ?SA? identifier took effect under state law in the state from which the rates were adopted.

WAGE DETERMINATION APPEALS PROCESS

1.) Has there been an initial decision in the matter? This can be:

- * an existing published wage determination
- * a survey underlying a wage determination

- * a Wage and Hour Division letter setting forth a position on a wage determination matter
- * a conformance (additional classification and rate) ruling

On survey related matters, initial contact, including requests for summaries of surveys, should be with the Wage and Hour National Office because National Office has responsibility for the Davis-Bacon survey program. If the response from this initial contact is not satisfactory, then the process described in 2.) and 3.) should be followed.

With regard to any other matter not yet ripe for the formal process described here, initial contact should be with the Branch of Construction Wage Determinations. Write to:

Branch of Construction Wage Determinations
 Wage and Hour Division
 U.S. Department of Labor
 200 Constitution Avenue, N.W.
 Washington, DC 20210

2.) If the answer to the question in 1.) is yes, then an interested party (those affected by the action) can request review and reconsideration from the Wage and Hour Administrator (See 29 CFR Part 1.8 and 29 CFR Part 7). Write to:

Wage and Hour Administrator
 U.S. Department of Labor
 200 Constitution Avenue, N.W.
 Washington, DC 20210

The request should be accompanied by a full statement of the interested party's position and by any information (wage payment data, project description, area practice material, etc.) that the requestor considers relevant to the issue.

3.) If the decision of the Administrator is not favorable, an interested party may appeal directly to the Administrative Review Board (formerly the Wage Appeals Board). Write to:

Administrative Review Board
 U.S. Department of Labor
 200 Constitution Avenue, N.W.
 Washington, DC 20210

4.) All decisions by the Administrative Review Board are final.

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END OF GENERAL DECISION"

"General Decision Number: OH20240001 11/08/2024

Superseded General Decision Number: OH20230001

State: Ohio

Construction Types: Heavy and Highway

Counties: Ohio Statewide.

Heavy and Highway Construction Projects

Note: Contracts subject to the Davis-Bacon Act are generally required to pay at least the applicable minimum wage rate required under Executive Order 14026 or Executive Order 13658. Please note that these Executive Orders apply to covered contracts entered into by the federal government that are subject to the Davis-Bacon Act itself, but do not apply to contracts subject only to the Davis-Bacon Related Acts, including those set forth at 29 CFR 5.1(a)(1).

<p>If the contract is entered into on or after January 30, 2022, or the contract is renewed or extended (e.g., an option is exercised) on or after January 30, 2022:</p>	<p>. Executive Order 14026 generally applies to the contract. . The contractor must pay all covered workers at least \$17.20 per hour (or the applicable wage rate listed on this wage determination, if it is higher) for all hours spent performing on the contract in 2024.</p>
<p>If the contract was awarded on or between January 1, 2015 and January 29, 2022, and the contract is not renewed or extended on or after January 30, 2022:</p>	<p>. Executive Order 13658 generally applies to the contract. . The contractor must pay all covered workers at least \$12.90 per hour (or the applicable wage rate listed on this wage determination, if it is higher) for all hours spent performing on that contract in 2024.</p>

The applicable Executive Order minimum wage rate will be adjusted annually. If this contract is covered by one of the Executive Orders and a classification considered necessary for performance of work on the contract does not appear on this wage determination, the contractor must still submit a conformance request.

Additional information on contractor requirements and worker protections under the Executive Orders is available at <http://www.dol.gov/whd/govcontracts>.

Modification Number	Publication Date
0	01/05/2024
1	01/26/2024
2	03/08/2024
3	04/05/2024
4	07/05/2024

5	07/26/2024
6	08/23/2024
7	09/06/2024
8	09/06/2024
9	11/08/2024

BROH0001-001 06/01/2023

DEFIANCE, FULTON (Excluding Fulton, Amboy & Swan Creek Townships), HENRY (Excluding Monroe, Bartlow, Liberty, Washington, Richfield, Marion, Damascus & Townships & that part of Harrison Township outside corporate limits of city of Napoleon), PAULDING, PUTNAM and WILLIAMS COUNTIES

	Rates	Fringes
Bricklayer, Stonemason.....	\$ 32.40	19.30

BROH0001-004 06/01/2023

	Rates	Fringes
CEMENT MASON/CONCRETE FINISHER...	\$ 32.40	19.30

BROH0003-002 06/01/2023

FULTON (Townships of Amboy, Swan Creek & Fulton), HENRY (Townships of Washington, Damascus, Richfield, Bartlow, Liberty, Harrison, Monroe, & Marion), LUCAS and WOOD (Townships of Perrysburg, Ross, Lake, Troy, Freedom, Montgomery, Webster, Center, Portage, Middleton, Plain, Liberty, Henry, Washington, Weston, Milton, Jackson & Grand Rapids) COUNTIES

	Rates	Fringes
Bricklayer, Stonemason.....	\$ 32.40	19.30

BROH0005-003 06/01/2020

CUYAHOGA, LORAIN & MEDINA (Hinckley, Granger, Brunswick, Liverpool, Montville, York, Homer, Harrisville, Chatham, Litchfield & Spencer Townships and the city of Medina)

	Rates	Fringes
BRICKLAYER		
BRICKLAYERS; CAULKERS;		
CLEANERS; POINTERS; &		
STONEMASONS.....	\$ 36.64	17.13
SANDBLASTERS.....	\$ 36.39	17.13
SEWER BRICKLAYERS & STACK		
BUILDERS.....	\$ 36.64	17.13
SWING SCAFFOLDS.....	\$ 37.14	17.13

BROH0006-005 06/01/2023

CARROLL, COLUMBIANA (Knox, Butler, West & Hanover Townships), STARK & TUSCARAWAS

	Rates	Fringes
Bricklayer, Stonemason.....	\$ 32.40	19.30

BROH0007-002 06/01/2023

LAWRENCE

	Rates	Fringes
Bricklayer, Stonemason.....	\$ 32.40	19.30

BROH0007-005 06/01/2023

PORTAGE & SUMMIT

	Rates	Fringes
BRICKLAYER.....	\$ 32.40	19.30

BROH0007-010 06/01/2023

PORTAGE & SUMMIT

	Rates	Fringes
MASON - STONE.....	\$ 32.40	19.30

BROH0008-001 06/01/2023

COLUMBIANA (Salem, Perry, Fairfield, Center, Elk Run, Middleton, & Unity Townships and the city of New Waterford), MAHONING & TRUMBULL

	Rates	Fringes
BRICKLAYER.....	\$ 32.40	19.30

BROH0009-002 06/01/2023

BELMONT & MONROE COUNTIES and the Townships of Warren & Mt. Pleasant and the Village of Dillonvale in JEFFERSON COUNTY

	Rates	Fringes
Bricklayer, Stonemason.....	\$ 32.40	19.30
Refractory.....	\$ 31.45	19.01

BROH0010-002 06/01/2023

COLUMBIANA (St. Clair, Madison, Wayne, Franklin, Washington, Yellow Creek & Liverpool Townships) & JEFFERSON (Brush Creek & Saline Townships)

	Rates	Fringes
Bricklayer, Stonemason.....	\$ 32.40	19.30

BROH0014-002 06/01/2023

HARRISON & JEFFERSON (Except Mt. Pleasant, Warren, Brush Creek, Saline & Salineville Townships & the Village of Dillonvale)

	Rates	Fringes
Bricklayer, Stonemason.....	\$ 32.40	19.30

BROH0016-002 06/01/2023

ASHTABULA, GEAUGA, and LAKE COUNTIES

	Rates	Fringes
Bricklayer, Stonemason.....	\$ 32.40	19.30

BROH0018-002 06/01/2023

BROWN, BUTLER, CLERMONT, HAMILTON, PREBLE (Gasper, Dixon, Israel, Lanier, Somers & Gratis Townships) & WARREN COUNTIES:

	Rates	Fringes
Bricklayer, Stonemason.....	\$ 32.40	19.30

BROH0022-004 06/01/2023

CHAMPAIGN, CLARK, CLINTON, DARKE, GREENE, HIGHLAND, LOGAN, MIAMI, MONTGOMERY, PREBLE (Jackson, Monroe, Harrison, Twin, Jefferson & Washington Townships) and SHELBY COUNTIES

	Rates	Fringes
Bricklayer, Stonemason.....	\$ 32.40	19.30

BROH0032-001 06/01/2023

GALLIA & MEIGS

	Rates	Fringes
Bricklayer, Stonemason.....	\$ 32.40	19.30

BROH0035-002 06/01/2023

ALLEN, AUGLAIZE, MERCER and VAN WERT COUNTIES

	Rates	Fringes
Bricklayer, Stonemason.....	\$ 32.40	19.30

BROH0039-002 06/01/2023

ADAMS & SCIOTO

	Rates	Fringes
Bricklayer, Stonemason.....	\$ 32.40	19.30

BROH0040-003 06/01/2023

ASHLAND, CRAWFORD, HARDIN, HOLMES, MARION, MORROW, RICHLAND, WAYNE and WYANDOT (Except Crawford, Ridge, Richland & Tymochtee Townships) COUNTIES

	Rates	Fringes
Bricklayer, Stonemason.....	\$ 32.40	19.30

FOOTNOTE: Layout Man and Sawman rate: \$1.00 per hour above journeyman rate.

Free standing stack work ground level to top of stack;

Sandblasting and laying of carbon masonry material in swing stage and/or scaffold; Ramming and spading of plastics and gunniting: \$1.50 per hour above journeyman rate.
""Hot"" work: \$2.50 above journeyman rate.

BROH0044-002 06/01/2023

Rates Fringes

Bricklayer, Stonemason
COSHOCOTON, FAIRFIELD,
GUERNSEY, HOCKING, KNOX,
KICKING, MORGAN,
MUSKINGUM, NOBLE (Beaver,
Buffalo, Seneca & Wayne
Townships) & PERRY
COUNTIES:.....\$ 32.40 19.30

BROH0045-002 06/01/2023

FAYETTE, JACKSON, PIKE, ROSS and VINTON COUNTIES

Rates Fringes

Bricklayer, Stonemason.....\$ 35.39 17.47

BROH0046-002 06/01/2023

ERIE, HANCOCK, HURON, OTTAWA, SANDUSKY, SENECA, WOOD (Perry & Bloom Townships) and WYANDOT (Tymochtee, Crawford, Ridge & Richland Townships) COUNTIES & the Islands of Lake Erie north of Sandusky

Rates Fringes

Bricklayer, Stonemason.....\$ 32.40 19.30

FOOTNOTE: Layout Man and Sawman rate: \$1.00 per hour above journeyman rate.
Free standing stack work ground level to top of stack;
Sandblasting and laying of carbon masonry material in swing stage and/or scaffold; Ramming and spading of plastics and gunniting: \$1.50 per hour above journeyman rate.
""Hot"" work: \$2.50 above journeyman rate.

BROH0052-001 06/01/2023

ATHENS COUNTY

Rates Fringes

Bricklayer, Stonemason.....\$ 32.40 19.30

BROH0052-003 06/01/2023

NOBLE (Brookfield, Noble, Center, Sharon, Olive, Enoch, Stock, Jackson, Jefferson & Elk Townships) and WASHINGTON COUNTIES

Rates Fringes

Bricklayer, Stonemason.....\$ 32.40 19.30

BROH0055-003 06/01/2023

DELAWARE, FRANKLIN, MADISON, PICKAWAY and UNION COUNTIES

	Rates	Fringes
Bricklayer, Stonemason.....	\$ 32.40	19.30

CARP0003-004 05/01/2017

MAHONING & TRUMBULL

	Rates	Fringes
CARPENTER.....	\$ 26.20	17.42

CARP0069-003 05/01/2017

CARROLL, STARK, TUSCARAWAS & WAYNE

	Rates	Fringes
CARPENTER.....	\$ 25.98	15.98

CARP0069-006 05/01/2017

COSHOCTON, HOLMES, KNOX & MORROW

	Rates	Fringes
CARPENTER.....	\$ 24.04	15.29

CARP0171-002 05/01/2024

BELMONT, COLUMBIANA, HARRISON, JEFFERSON & MONROE

	Rates	Fringes
CARPENTER.....	\$ 31.82	25.11

CARP0200-002 05/01/2024

ADAMS, ATHENS, DELAWARE, FAIRFIELD, FAYETTE, FRANKLIN, GALLIA, GUERNSEY, HIGHLAND, HOCKING, JACKSON, LAWRENCE, LICKING, MADISON, MARION, MEIGS, MORGAN, MUSKINGUM, NOBLE, PERRY, PICKAWAY, PIKE, ROSS, SCIOTO, UNION, VINTON and WASHINGTON COUNTIES

	Rates	Fringes
CARPENTER.....	\$ 33.15	22.43
Diver.....	\$ 39.41	10.40
PILEDRIVERMAN.....	\$ 33.15	22.43

CARP0248-005 07/01/2008

LUCAS & WOOD

	Rates	Fringes
CARPENTER.....	\$ 27.27	14.58

CARP0248-008 07/01/2008

Rates Fringes

CARPENTER

DEFIANCE, FULTON, HANCOCK,
HENRY, PAULDING & WILLIAMS
COUNTIES.....

\$ 23.71 13.28

CARP0254-002 05/01/2017

ASHTABULA, CUYAHOGA, GEAUGA & LAKE

Rates Fringes

CARPENTER.....\$ 32.40 16.97

CARP0372-002 05/01/2024

ALLEN, AUGLAIZE, HARDIN, MERCER, PUTNAM & VAN WERT

Rates Fringes

CARPENTER.....\$ 30.73 25.09

CARP0639-003 05/01/2017

MEDINA, PORTAGE & SUMMIT

Rates Fringes

CARPENTER.....\$ 30.42 16.99

CARP0735-002 05/01/2024

ASHLAND, ERIE, HURON, LORAIN & RICHLAND

Rates Fringes

CARPENTER.....\$ 33.43 22.31

CARP1311-001 05/01/2017

BROWN, BUTLER, CHAMPAIGN, CLARK, CLERMONT, CLINTON, DARKE,
GREENE, HAMILTON, LOGAN, MIAMI, MONTGOMERY, PREBLE, SHELBY &
WARREN

Rates Fringes

Carpenter & Piledrivermen.....\$ 29.34 15.95
Diver.....\$ 40.58 9.69

CARP1393-002 05/01/2024

CRAWFORD, DEFIANCE, FULTON, HANCOCK, HENRY, LUCAS, OTTAWA,
PAULDING, SANDUSKY, SENECA, WILLIAMS & WOOD

Rates Fringes

Piledrivermen & Diver's Tender...\$ 36.84 27.72

DIVERS - \$250.00 per day

CARP1393-003 05/01/2024

ALLEN, AUGLAIZE, HARDIN, MERCER, PUTNAM, VAN WERT & WYANDOT

Rates Fringes

Piledrivermen & Diver's Tender...\$ 34.68 27.60

DIVERS - \$250.00 per day

 CARP1871-006 05/01/2017

BELMONT, HARRISON, & MONROE

	Rates	Fringes
Diver, Wet.....	\$ 48.11	17.33
Piledrivermen; Diver, Dry.....	\$ 32.07	17.33

 CARP1871-008 05/01/2017

ASHLAND, ASHTABULA, CUYAHOGA, ERIE, GEAUGA, HURON, LAKE,
 LORAIN, MEDINA, PORTAGE, RICHLAND & SUMMIT

	Rates	Fringes
Diver, Wet.....	\$ 45.80	18.84
Piledrivermen; Diver, Dry.....	\$ 30.53	18.84

 CARP1871-014 05/01/2017

CARROLL, STARK, TUSCARAWAS & WAYNE

	Rates	Fringes
Diver, Wet.....	\$ 38.34	16.95
Piledrivermen; Diver, Dry.....	\$ 25.56	16.95

 CARP1871-015 05/01/2017

COSHOCTON, HOLMES, KNOX & MORROW

	Rates	Fringes
Diver, Wet.....	\$ 37.34	16.07
Piledrivermen; Diver, Dry.....	\$ 24.89	16.07

 CARP1871-017 05/01/2017

MAHONING & TRUMBULL

	Rates	Fringes
Diver, Wet.....	\$ 40.65	17.62
Piledrivermen; Diver, Dry.....	\$ 27.10	17.62

 CARP2235-012 01/01/2014

COLUMBIANA & JEFFERSON

	Rates	Fringes
PILEDRIVERMAN.....	\$ 31.74	16.41

 CARP2239-001 07/01/2008

CRAWFORD, OTTAWA, SANDUSKY, SENECA & WYANDOT

	Rates	Fringes
CARPENTER.....	\$ 23.71	13.28

 ELEC0008-002 05/29/2023

DEFIANCE, FULTON, HANCOCK, HENRY, LUCAS, OTTAWA, PAULDING, PUTNAM, SANDUSKY, SENECA, WILLIAMS & WOOD

	Rates	Fringes
CABLE SPLICER.....	\$ 38.98	18.96
ELECTRICIAN.....	\$ 46.38	4.5%+21.96

ELEC0032-003 06/01/2024

ALLEN, AUGLAIZE, HARDIN, LOGAN, MERCER, SHELBY, VAN WERT & WYANDOT (Crawford, Jackson, Marseilles, Mifflin, Ridgeland, Ridge & Salem Townships)

	Rates	Fringes
ELECTRICIAN.....	\$ 35.17	22.92

ELEC0038-002 04/29/2024

CUYAHOGA, GEAUGA (Bainbridge, Chester & Russell Townships) & LORAIN (Columbia Township)

	Rates	Fringes
ELECTRICIAN Excluding Sound & Communications Work.....	\$ 45.23	23.88

FOOTNOTES;

- a. 6 Paid Holidays: New Year's Day; Memorial Day; July 4th; Labor Day; Thanksgiving Day; & Christmas Day
- b. 1 week's paid vacation for 1 year's service; 2 weeks' paid vacation for 2 or more years' service

ELEC0038-008 04/24/2023

CUYAHOGA, GEAUGA (Bainbridge, Chester & Russell Townships) & LORAIN (Columbia Township)

	Rates	Fringes
Sound & Communication Technician Communications Technician...	\$ 29.80	13.80
Installer Technician.....	\$ 28.55	13.76

FOOTNOTES;

- a. 6 Paid Holidays: New Year's Day; Memorial Day; July 4th; Labor Day; Thanksgiving Day; & Christmas Day
- b. 1 week's paid vacation for 1 year's service; 2 weeks' paid vacation for 2 or more years' service

ELEC0064-003 11/27/2023

COLUMBIANA (Butler, Fairfield, Perry, Salem & Unity Townships) MAHONING (Austintown, Beaver, Berlin, Boardman, Canfield, Ellsworth, Coitsville, Goshen, Green, Jackson, Poland, Springfield & Youngstown Townships), & TRUMBULL (Hubbard & Liberty Townships)

	Rates	Fringes
ELECTRICIAN.....	\$ 37.90	20.08

ELEC0071-001 01/01/2024

ASHLAND, CHAMPAIGN, CLARK, COSHOCTON, CRAWFORD, DELAWARE, FAIRFIELD, FAYETTE, FRANKLIN, GUERNSEY, HIGHLAND, HOCKING, JACKSON (Coal, Jackson, Liberty, Milton, Washington & Wellston Townships), KNOX, LICKING, MADISON, MARION, MONROE, MORGAN, MORROW, MUSKINGUM, NOBLE, PERRY, PICKAWAY, PIKE (Beaver, Benton, Jackson, Mifflin, Pebble, Peepee, Perry & Seal Townships), RICHLAND, ROSS, TUSCARAWAS (Auburn, Bucks, Clay, Jefferson, Oxford, Perry, Salem, Rush, Washington & York Townships), UNION, VINTON (Clinton, Eagle, Elk, Harrison, Jackson, Richland & Swan Townships), and WASHINGTON COUNTIES

	Rates	Fringes
Line Construction		
Equipment Operators.....	\$ 39.11	17.14
Groundmen.....	\$ 25.90	13.97
Linemen & Cable Splicers....	\$ 44.52	18.43

ELEC0071-004 01/01/2024

AUGLAIZE, CLINTON, DARKE, GREENE, LOGAN, MERCER, MIAMI, MONTGOMERY, PREBLE, and SHELBY COUNTIES

	Rates	Fringes
Line Construction		
Equipment Operator.....	\$ 39.11	17.14
Groundman.....	\$ 25.90	13.97
Lineman & Cable Splicers....	\$ 44.52	18.43

ELEC0071-005 01/01/2024

ASHTABULA, CUYAHOGA, GEAUGA, LAKE & LORAIN

	Rates	Fringes
LINE CONSTRUCTION: Equipment Operator		
DOT/Traffic Signal & Highway Lighting Projects...	\$ 37.43	26%+7.75
Municipal Power/Transit Projects.....	\$ 47.86	27%+7.65
LINE CONSTRUCTION: Groundman		
DOT/Traffic Signal & Highway Lighting Projects...	\$ 25.63	26%+7.75
Municipal Power/Transit Projects.....	\$ 31.91	27%+7.65
LINE CONSTRUCTION: Linemen/Cable Splicer		
DOT/Traffic Signal & Highway Lighting Projects...	\$ 42.20	26%+7.75
Municipal Power/Transit Projects.....	\$ 53.18	27%+7.65

ELEC0071-008 01/01/2024

COLUMBIANA, MAHONING, and TRUMBULL COUNTIES

	Rates	Fringes
Line Construction		
Equipment Operator.....	\$ 39.11	17.14
Groundman.....	\$ 25.90	13.97
Lineman & Cable Splicers....	\$ 44.52	18.43

 ELEC0071-010 01/01/2024

	Rates	Fringes
Line Construction		
Equipment Operator.....	\$ 39.11	17.14
Groundman.....	\$ 25.90	13.97
Lineman & Cable Splicers....	\$ 44.52	18.43

 ELEC0071-013 01/01/2024

BROWN, BUTLER, CLERMONT, HAMILTON, and WARREN COUNTIES

	Rates	Fringes
Line Construction		
Equipment Operator.....	\$ 39.11	17.14
Groundman.....	\$ 25.90	13.97
Lineman & Cable Splicers....	\$ 44.52	18.43

 ELEC0071-014 01/01/2024

ADAMS, ATHENS, GALLIA, JACKSON (Bloomfield, Franklin, Hamilton, Lick, Jefferson, Scioto & Madison Townships), LAWRENCE, MEIGS, PIKE (Camp Creek, Marion, Newton, Scioto, Sunfish & Union Townships), SCIOTO & VINTON (Brown, Knox, Madison, Vinton & Wilkesville Townships)

	Rates	Fringes
Line Construction		
Equipment Operator.....	\$ 39.11	17.14
Groundman.....	\$ 25.90	13.97
Lineman & Cable Splicers....	\$ 44.52	18.43

 ELEC0082-002 12/04/2023

CLINTON, DARKE, GREENE, MIAMI, MONTGOMERY, PREBLE & WARREN (Wayne, Clear Creek & Franklin Townships)

	Rates	Fringes
ELECTRICIAN.....	\$ 36.00	21.99

 * ELEC0082-006 11/28/2022

CLINTON, DARKE, GREENE, MIAMI, MONTGOMERY, PREBLE & WARREN (Wayne, Clear Creek & Franklin Townships)

	Rates	Fringes
Sound & Communication Technician		
Cable Puller.....	\$ 13.10 **	4.76
Installer/Technician.....	\$ 26.20	13.89

ELEC0129-003 02/26/2024

LORAIN (Except Columbia Township) & MEDINA (Litchfield & Liverpool Townships)

	Rates	Fringes
ELECTRICIAN.....	\$ 41.40	18.36

ELEC0129-004 02/26/2024

ERIE & HURON (Lyme, Ridgefield, Norwalk, Townsend, Wakeman, Sherman, Peru, Bronson, Hartland, Clarksfield, Norwich, Greenfield, Fairfield, Fitchville & New London Townships)

	Rates	Fringes
ELECTRICIAN.....	\$ 41.40	18.36

ELEC0141-003 06/02/2024

BELMONT COUNTY

	Rates	Fringes
CABLE SPLICER.....	\$ 42.94	27.74
ELECTRICIAN.....	\$ 39.04	27.62

ELEC0212-003 11/26/2018

BROWN, CLERMONT & HAMILTON

	Rates	Fringes
Sound & Communication Technician.....	\$ 24.35	10.99

ELEC0212-005 06/03/2024

BROWN, CLERMONT, and HAMILTON COUNTIES

	Rates	Fringes
ELECTRICIAN.....	\$ 35.43	22.05

* ELEC0245-001 08/26/2024

ALLEN, HARDIN, VAN WERT & WYANDOT (Crawford, Jackson, Marseilles, Mifflin, Richland, Ridge & Salem Townships)

	Rates	Fringes
Line Construction		
Equipment Operator.....	\$ 32.95	28%+7.85
Groundman Truck Driver.....	\$ 20.59	28%+7.85
Lineman.....	\$ 47.07	28%+7.85

FOOTNOTE: a. Half day's Paid Holiday: The last 4 hours of the workday prior to Christmas or New Year's Day

ELEC0245-003 01/01/2024

DEFIANCE, FULTON, HANCOCK, HENRY, HURON, LUCAS, OTTAWA,

PAULDING, PUTNAM, SANDUSKY, SENECA, WILLIAMS, and WOOD COUNTIES

	Rates	Fringes
Line Construction		
Cable Splicer.....	\$ 52.53	7.75+27%
Groundman/Truck Driver.....	\$ 19.99	7.75+27%
Heli-arc Welding.....	\$ 45.98	7.75+27%
Lineman.....	\$ 45.68	7.75+27%
Operator - Class 1.....	\$ 36.54	7.75+27%
Operator - Class 2.....	\$ 31.98	7.75+27%
Traffic Signal & Lighting Technician.....	\$ 41.11	7.75+27%

FOOTNOTE: a. 6 Observed Holidays: New Year's Day; Memorial Day; Independence Day; Labor Day; Thanksgiving Day; & Christmas Day. Employees who work on a holiday shall be paid at a rate of double their applicable classified straight-time rates for the work performed on such holiday.

 * ELEC0245-004 08/26/2024

ERIE COUNTY

	Rates	Fringes
Line Construction		
Cable Splicer.....	\$ 49.14	26.75%+6.75
Cablesplicer.....	\$ 54.13	28%7.85
Groundman/Truck Driver.....	\$ 20.59	28%7.85
Lineman.....	\$ 47.07	28%7.85
Operator - Class 1.....	\$ 36.70	28%7.85
Operator - Class 2.....	\$ 32.95	28%7.85

FOOTNOTE: a. 6 Observed Holidays: New Year's Day; Memorial Day; Independence Day; Labor Day; Thanksgiving Day; & Christmas Day. Employees who work on a holiday shall be paid at a rate of double their applicable classified straight-time rates for the work performed on such holiday.

 * ELEC0246-001 10/30/2023

	Rates	Fringes
ELECTRICIAN.....	\$ 46.75	32.99

FOOTNOTE: a. 1 1/2 Paid Holidays: The last scheduled workday prior to Christmas & 4 hours on Good Friday.

 * ELEC0306-005 05/27/2024

MEDINA (Brunswick, Chatham, Granger, Guilford, Harrisville, Hinckley, Homer, Lafayette, Medina, Montville, Sharon, Spencer, Wadsworth, Westfield & York Townships), PORTAGE (Atwater, Aurora, Brimfield, Deerfield, Franklin, Mantua, Randolph, Ravenna, Rootstown, Shalersville, Streetsboro & Suffield Townships), SUMMIT & WAYNE (Baughman, Canaan, Chester, Chippewa, Congress, Green, Milton, & Wayne Townships)

	Rates	Fringes
CABLE SPLICER.....	\$ 46.81	20.95

ELECTRICIAN.....\$ 42.55 20.95

ELEC0317-002 05/29/2023

GALLIA & LAWRENCE

Rates Fringes

CABLE SPLICER.....\$ 32.68 18.13
ELECTRICIAN.....\$ 37.15 28.48

ELEC0540-005 01/01/2024

CARROLL (Northern half, including Fox, Harrison, Rose & Washington Townships), COLUMBIANA (Knox Township), HOLMES, MAHONING (Smith Township), STARK, TUSCARAWAS (North of Auburn, Clay, Rush & York Townships), and WAYNE (South of Baughman, Chester, Green & Wayne Townships) COUNTIES

Rates Fringes

ELECTRICIAN.....\$ 36.96 28.18

ELEC0573-003 05/27/2024

ASHTABULA (Colebrook, Wayne, Williamsfield, Orwell & Windsor Townships), GEAUGA (Auburn, Middlefield, Parkman & Troy Townships), MAHONING (Milton Township), PORTAGE (Charlestown, Edinburg, Freedom, Hiram, Nelson, Palmyra, Paris & Windham Townships), and TRUMBULL (Except Liberty & Hubbard Townships)

Rates Fringes

ELECTRICIAN.....\$ 40.40 22.20

ELEC0575-001 05/29/2023

ADAMS, FAYETTE, HIGHLAND, HOCKING, JACKSON (Bloomfield, Franklin, Hamilton, Jefferson, Lick, Madison, Scioto, Coal, Jackson, Liberty, Milton & Washington Townships), PICKAWAY (Deer Creek, Perry, Pickaway, Salt Creek & Wayne Townships), PIKE (Beaver, Benton, Jackson, Mifflin, Pebble, PeePee, Perry, Seal, Camp Creek, Newton, Scioto, Sunfish, Union & Marion Townships), ROSS, SCIOTO & VINTON (Clinton, Eagle, Elk, Harrison, Jackson, Richland & Swan Townships)

Rates Fringes

ELECTRICIAN.....\$ 37.00 22.26

ELEC0648-001 08/29/2023

BUTLER and WARREN COUNTIES (Deerfield, Hamilton, Harlan, Massie, Salem, Turtle Creek, Union & Washington Townships)

Rates Fringes

CABLE SPLICER.....\$ 30.50 18.23
ELECTRICIAN.....\$ 34.00 21.98

ELEC0673-004 05/27/2024

ASHTABULA (Excluding Orwell, Colebrook, Williamsfield, Wayne &

Windsor Townships), GEAUGA (Burton, Chardon, Claridon, Hambden, Huntsburg, Montville, Munson, Newbury & Thompson Townships) and LAKE COUNTIES

	Rates	Fringes
CABLE SPLICER.....	\$ 33.81	21.47
ELECTRICIAN.....	\$ 39.64	23.86

* ELEC0683-002 05/27/2024

CHAMPAIGN, CLARK, DELAWARE, FAIRFIELD, FRANKLIN, MADISON, PICKAWAY (Circleville, Darby, Harrison, Jackson, Madison, Monroe, Muhlenberg, Scioto, Walnut & Washington Townships), and UNION COUNTIES

	Rates	Fringes
CABLE SPLICER.....	\$ 41.50	24.19
ELECTRICIAN.....	\$ 40.50	25.20

ELEC0688-003 05/30/2022

ASHLAND, CRAWFORD, HURON (Richmond, New Haven, Ripley & Greenwich Townships), KNOX (Liberty, Clinton, Union, Howard, Monroe, Middleberry, Morris, Wayne, Berlin, Pike, Brown & Jefferson Townships), MARION, MORROW, RICHLAND and WYANDOT (Sycamore, Crane, Eden, Pitt, Antrim & Tymochtee Townships) COUNTIES

	Rates	Fringes
ELECTRICIAN.....	\$ 32.30	21.83

ELEC0972-002 06/01/2023

ATHENS, MEIGS, MONROE, MORGAN, NOBLE, VINTON (Brown, Knox, Madison, Vinton & Wilkesville Townships), and WASHINGTON COUNITIES

	Rates	Fringes
CABLE SPLICER.....	\$ 35.70	30.26
ELECTRICIAN.....	\$ 35.45	30.25

ELEC1105-001 05/29/2023

COSHOCTON, GUERNSEY, KNOX (Jackson, Clay, Morgan, Miller, Milford, Hilliar, Butler, Harrison, Pleasant & College Townships), LICKING, MUSKINGUM, PERRY, and TUSCARAWAS (Auburn, York, Clay, Jefferson, Rush, Oxford, Washington, Salem, Perry & Bucks Townships) COUNTIES

	Rates	Fringes
ELECTRICIAN.....	\$ 36.45	24.22

ENGI0018-003 05/01/2024

ASHTABULA, CUYAHOGA, ERIE, GEAUGA, LAKE, LORAIN, MEDINA, PORTAGE, and SUMMIT COUNTIES

	Rates	Fringes
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POWER EQUIPMENT OPERATOR

GROUP 1.....	\$ 45.63	16.41
GROUP 2.....	\$ 45.53	16.41
GROUP 3.....	\$ 44.49	16.41
GROUP 4.....	\$ 43.27	16.41
GROUP 5.....	\$ 37.98	16.41
GROUP 6.....	\$ 46.63	16.41
GROUP 7.....	\$ 46.63	16.41

OPERATING ENGINEER CLASSIFICATIONS

GROUP 1 - Air Compressor on Steel Erection; Barrier Moving Machine; Boiler Operator on Compressor or Generator when mounted on a Rig; Cableway; Combination Concrete Mixer & Tower; Concrete Plant (over 4 yd. Capacity); Concrete Pump; Crane (All Types, Including Boom Truck, Cherry Picker); Crane-Compact, Track or Rubber over 4,000 lbs. capacity; Cranes-Self Erecting, Stationary, Track or Truck (All Configurations); Derrick; Dragline; Dredge (Dipper, Clam or Suction); Elevating Grader or Euclid Loader; Floating Equipment (All Types); Gradall; Helicopter Crew (Operator-Hoist or Winch); Hoe (all types); Hoisting Engine on Shaft or Tunnel Work; Hydraulic Gantry (Lifting System); Industrial-Type Tractor; Jet Engine Dryer (D8 or D9) Diesel Tractor; Locomotive (Standard Gauge); Maintenance Operator Class A; Mixer, Paving (Single or Double Drum); Mucking Machine; Multiple Scraper; Piledriving Machine (All Types); Power Shovel; Prentice Loader; Quad 9 (Double Pusher); Rail Tamper (with auto lifting & aligning device); Refrigerating Machine (Freezer Operation); Rotary Drill, on Caisson work; Rough Terrain Fork Lift with Winch/Hoist; Side-Boom; Slip-Form Paver; Tower Derrick; Tree Shredder; Trench Machine (Over 24" wide); Truck Mounted Concrete Pump; Tug Boat; Tunnel Machine and/or Mining Machine; Wheel Excavator; and Asphalt Plant Engineer (Cleveland District Only).

GROUP 2 - Asphalt Paver; Automatic Subgrader Machine, Self-Propelled (CMI Type); Bobcat Type and/or Skid Steer Loader with Hoe Attachment Greater than 7,000 lbs.; Boring Machine More than 48"; Bulldozer; Endloader; Horizontal Directional Drill (Over 50,000 ft lbs thrust); Hydro Milling Machine; Kolman-type Loader (production type-Dirt); Lead Greaseman; Lighting & Traffic Signal Installation Equipment (includes all groups or classifications); Material Transfer Equipment (Shuttle Buggy) Asphalt; Pettibone-Rail Equipment; Power Grader; Power Scraper; Push Cat; Rotomill (all), Grinders & Planers of All types; Trench Machine (24" wide & under); Vermeer type Concrete Saw; and Maintenance Operators (Portage and Summit Counties Only).

GROUP 3 - A-Frame; Air Compressor on Tunnel Work (low pressure); Asphalt Plant Engineer (Portage and Summit Counties Only); Bobcat-type and/or Skid Steer Loader with or without Attachments; Highway Drills (all types); Locomotive (narrow gauge); Material Hoist/Elevator; Mixer, Concrete (more than one bag capacity); Mixer, one bag capacity (Side Loader); Power Boiler (Over 15 lbs. Pressure) Pump Operator installing & operating Well Points; Pump (4" & over discharge); Roller, Asphalt; Rotovator (lime soil stabilizer); Switch & Tie Tampers (without lifting & aligning device); Utility Operator (Small equipment); Welding Machines; and Railroad Tie

Insertor/Remover; Articulating/straight bed end dumps if assigned (minus \$4.00 per hour.

GROUP 4 - Backfiller; Ballast Re-locator; Bars, Joint & Mesh Installing Machine; Batch Plant; Boring Machine Operator (48" or less); Bull Floats; Burlap & Curing Machine; Concrete Plant (capacity 4 yd. & under); Concrete Saw (Multiple); Conveyor (Highway); Crusher; Deckhand; Farm-type Tractor with attachments (highway); Finishing Machine; Fireperson, Floating Equipment (all types); Forklift; Form Trencher; Hydro Hammer expect masonry; Hydro Seeder; Pavement Breaker; Plant Mixer; Post Driver; Post Hole Digger (Power Auger); Power Brush Burner; Power Form Handling Equipment; Road Widening Trencher; Roller (Brick, Grade & Macadam); Self-Propelled Power Spreader; Self-Propelled Power Subgrader; Steam Fireperson; Tractor (Pulling Sheepfoot, Roller or Grader); and Vibratory Compactor with Integral Power.

GROUP 5 - Compressor (Portable, Sewer, Heavy & Highway); Drum Fireperson (Asphalt Plant); Generator; Masonry Fork Lift; Inboard-Outboard Motor Boat Launch; Oil Heater (asphalt plant); Oiler/Helper; Power Driven Heater; Power Sweeper & Scrubber; Pump (under 4" discharge); Signalperson; Tire Repairperson; VAC/ALLS; Cranes - Compact, track or rubber under 4,000 pound capacity; fueling and greasing; and Chainmen.

GROUP 6 - Master Mechanic & Boom from 150 to 180.

GROUP 7 - Boom from 180 and over.

ENGI0018-004 05/01/2024

ADAMS, ALLEN, ASHLAND, ATHENS, AUGLAIZE, BELMONT, BROWN, BUTLER, CARROLL, CHAMPAIGN, CLARK, CLERMONT, CLINTON, COSHOCTON, CRAWFORD, DARKE, DEFIANCE, DELAWARE, FAIRFIELD, FAYETTE, FRANKLIN, FULTON, GALLIA, GREENE, GUERNSEY, HAMILTON, HANCOCK, HARDIN, HARRISON, HENRY, HIGHLAND, HOCKING, HOLMES, HURON, JACKSON, JEFFERSON, KNOX, LAWRENCE, LICKING, LOGAN, LUCAS, MADISON, MARION, MEIGS, MERCER, MIAMI, MONROE, MONTGOMERY, MORGAN, MORROW, MUSKINGUM, NOBLE, OTTAWA, PAULDING, PERRY, PICKAWAY, PIKE, PREBLE, PUTNAM, RICHLAND, ROSS, SANDUSKY, SCIOTO, SENECA, SHELBY, STARK, TUSCARAWAS, UNION, VAN WERT, VINTON, WARREN, WASHINGTON, WAYNE, WILLIAMS, WOOD, and YANDOT COUNTIES

	Rates	Fringes
POWER EQUIPMENT OPERATOR		
GROUP 1.....	\$ 44.14	16.41
GROUP 2.....	\$ 44.02	16.41
GROUP 3.....	\$ 42.98	16.41
GROUP 4.....	\$ 41.80	16.41
GROUP 5.....	\$ 36.34	16.41
GROUP 6.....	\$ 45.14	16.41
GROUP 7.....	\$ 45.14	16.41

OPERATING ENGINEER CLASSIFICATIONS

GROUP 1 - Air Compressor on Steel Erection; Barrier Moving Machine; Boiler Operator on Compressor or Generator when mounted on a Rig; Cableway; Combination Concrete Mixer & Tower; Concrete Plant (over 4 yd. Capacity); Concrete Pump; Crane (All Types, Including Boom Truck, Cherry Picker);

Crane-Compact, Track or Rubber over 4,000 lbs. capacity; Cranes-Self Erecting, Stationary, Track or Truck (All Configurations); Derrick; Dragline; Dredge (Dipper, Clam or Suction); Elevating Grader or Euclid Loader; Floating Equipment (All Types); Gradall; Helicopter Crew (Operator-Hoist or Winch); Hoe (all types); Hoisting Engine on Shaft or Tunnel Work; Hydraulic Gantry (Lifting System); Industrial-Type Tractor; Jet Engine Dryer (D8 or D9) Diesel Tractor; Locomotive (Standard Gauge); Maintenance Operator Class A; Mixer, Paving (Single or Double Drum); Mucking Machine; Multiple Scraper; Piledriving Machine (All Types); Power Shovel; Prentice Loader; Quad 9 (Double Pusher); Rail Tamper (with auto lifting & aligning device); Refrigerating Machine (Freezer Operation); Rotary Drill, on Caisson work; Rough Terrain Fork Lift with Winch/Hoist; Side-Boom; Slip-Form Paver; Tower Derrick; Tree Shredder; Trench Machine (Over 24" wide); Truck Mounted Concrete Pump; Tug Boat; Tunnel Machine and/or Mining Machine; and Wheel Excavator.

GROUP 2 - Asphalt Paver; Automatic Subgrader Machine, Self-Propelled (CMI Type); Bobcat Type and/or Skid Steer Loader with Hoe Attachment Greater than 7,000 lbs.; Boring Machine More than 48"; Bulldozer; Endloader; Hydro Milling Machine; Horizontal Directional Drill (over 50,000 ft. lbs. thrust); Kolman-type Loader (production type-Dirt); Lead Greaseman; Lighting & Traffic Signal Installation Equipment (includes all groups or classifications); Material Transfer Equipment (Shuttle Buggy) Asphalt; Pettibone-Rail Equipment; Power Grader; Power Scraper; Push Cat; Rotomill (all), Grinders & Planers of All types; Trench Machine (24" wide & under); and Vermeer type Concrete Saw.

GROUP 3 - A-Frame; Air Compressor on Tunnel Work (low pressure); Asphalt Plant Engineer; Bobcat-type and/or Skid Steer Loader with or without Attachments; Highway Drills (all types); Locomotive (narrow gauge); Material Hoist/Elevator; Mixer, Concrete (more than one bag capacity); Mixer, one bag capacity (Side Loader); Power Boiler (Over 15 lbs. Pressure) Pump Operator installing & operating Well Points; Pump (4" & over discharge); Railroad Tie Inserter/Remover; Roller, Asphalt; Rotovator (lime soil stabilizer); Switch & Tie Tampers (without lifting & aligning device); Utility Operator (Small equipment); and Welding Machines; Articulating/straight bed end dumps if assigned (minus \$4.00 per hour).

GROUP 4 - Backfiller; Ballast Re-locator; Bars, Joint & Mesh Installing Machine; Batch Plant; Boring Machine Operator (48" or less); Bull Floats; Burlap & Curing Machine; Concrete Plant (capacity 4 yd. & under); Concrete Saw (Multiple); Conveyor (Highway); Crusher; Deckhand; Farm-type Tractor with attachments (highway); Finishing Machine; Fireperson, Floating Equipment (all types); Fork Lift; Form Trencher; Hydro Hammer expect masonry; Hydro Seeder; Pavement Breaker; Plant Mixer; Post Driver; Post Hole Digger (Power Auger); Power Brush Burner; Power Form Handling Equipment; Road Widening Trencher; Roller (Brick, Grade & Macadam); Self-Propelled Power Spreader; Self-Propelled Power Subgrader; Steam Fireperson; Tractor (Pulling Sheepfoot, Roller or Grader); and Vibratory Compactor with Integral Power.

GROUP 5 - Compressor (Portable, Sewer, Heavy & Highway); Drum Fireperson (Asphalt Plant); Generator; Masonary Forklift; Inboard-Outboard Motor Boat Launch; Oil Heater (asphalt plant); Oiler/Helper; Power Driven Heater; Power Sweeper &

Scrubber; Pump (under 4" discharge); Signalperson; Tire Repairperson; VAC/ALLS; Cranes - Compact, track or rubber under 4,000 pound capacity; fueling and greasing; and Chainmen.

GROUP 6 - Master Mechanic & Boom from 150 to 180.

GROUP 7 - Boom from 180 and over.

 ENGI0066-023 06/01/2023

COLUMBIANA, MAHONING & TRUMBULL COUNTIES

	Rates	Fringes
POWER EQUIPMENT OPERATOR		
ASBESTOS; HAZARDOUS/TOXIC WASTE PROJECTS		
GROUP 1 - A & B.....	\$ 44.63	24.30
ASBESTOS; HAZARDOUS/TOXIC WASTE PROJECTS		
GROUP 2 - A & B.....	\$ 44.30	24.30
ASBESTOS; HAZARDOUS/TOXIC WASTE PROJECTS		
GROUP 3 - A & B.....	\$ 38.47	24.30
ASBESTOS; HAZARDOUS/TOXIC WASTE PROJECTS		
GROUP 4 - A & B.....	\$ 34.52	24.30
ASBESTOS; HAZARDOUS/TOXIC WASTE PROJECTS		
GROUP 5 - A & B.....	\$ 31.13	24.30
HAZARDOUS/TOXIC WASTE PROJECTS		
GROUP 1 - C & D.....	\$ 40.91	24.30
HAZARDOUS/TOXIC WASTE PROJECTS		
GROUP 2 - C & D.....	\$ 40.61	24.30
HAZARDOUS/TOXIC WASTE PROJECTS		
GROUP 3 - C & D.....	\$ 35.27	24.30
HAZARDOUS/TOXIC WASTE PROJECTS		
GROUP 4 - C & D.....	\$ 31.65	24.30
HAZARDOUS/TOXIC WASTE PROJECTS		
GROUP 5 - C & D.....	\$ 28.53	24.30
ALL OTHER WORK		
GROUP 1.....	\$ 37.19	24.30
ALL OTHER WORK		
GROUP 2.....	\$ 36.92	24.30
ALL OTHER WORK		
GROUP 3.....	\$ 32.06	24.30
ALL OTHER WORK		
GROUP 4.....	\$ 28.77	24.30
ALL OTHER WORK		
GROUP 5.....	\$ 25.94	24.30

GROUP 1 - Rig, Pile Driver or Caisson Type; & Rig, Pile Hydraulic Unit Attached

GROUP 2 - Asphalt Heater Planer; Backfiller with Drag Attachment; Backhoe; Backhoe with Shear attached; Backhoe-Rear Pivotal Swing; Batch Plant-Central Mix Concrete; Batch Plant, Portable concrete; Berm Builder-Automatic; Boat Derrick; Boat-Tug; Boring Machine Attached to Tractor; Bullclam; Bulldozer;

C.M.I. Road Builder & Similar Type; Cable Placer & Layer; Carrier-Straddle; Carryall-Scraper or Scoop; Chicago Boom; Compactor with Blade Attached; Concrete Saw (Vermeer or similar type); Concrete Spreader Finisher; Combination, Bidwell Machine; Crane; Crane-Electric Overhead; Crane-Rough Terrain; Crane-Side Boom; Crane-Truck; Crane-Tower; Derrick-Boom; Derrick-Car; Digger-Wheel (Not trencher or road widener); Double Nine; Drag Line; Dredge; Drill-Kenny or Similar Type; Easy Pour Median Barrier Machine (or similar type); Electromatic; Frankie Pile; Gradall; Grader; Gurry; Self-Propelled; Heavy Equipment Robotics Operator/Mechanic; Hoist-Monorail; Hoist-Stationary & Mobile Tractor; Hoist, 2 or 3 drum; Horizontal Directional Drill Operator; Jackall; Jumbo Machine; Kocal & Kuhlman; Land-Seagoing Vehicle; Loader, Elevating; Loader, Front End; Loader, Skid Steer; Locomotive; Mechanic/Welder; Metro Chip Harvester with Boom; Mucking Machine; Paver-Asphalt Finishing Machine; Paver-Road Concrete; Paver-Slip Form (C.M.I. or similar); Place Crete Machine with Boom; Post Driver (Carrier mounted); Power Driven Hydraulic Pump & Jack (When used in Slip Form or Lift Slab Construction); Pump Crete Machine; Regulator-Ballast; Hydraulic Power Unit not attached to Rig for Pile Drillings; Rigs-Drilling; Roto Mill or similar Full Lane (8' Wide & Over); Roto Mill or similar type (Under 8'); Shovel; Slip Form Curb Machine; Speedwing; Spikemaster; Stonecrusher; Tie Puller & Loader; Tie Tamper; Tractor-Double Boom; Tractor with Attachments; Truck-Boom; Truck-Tire; Trench Machine; Tunnel Machine (Mark 21 Java or similar); & Whirley (or similar type)

GROUP 3 - Asphalt Plant; Bending Machine (Pipeline or similar type); Boring machine, Motor Driven; Chip Harvester without Boom; Cleaning Machine, Pipeline Type; Coating Machine, Pipeline Type; Compactor; Concrete Belt Placer; Concrete Finisher; Concrete Planer or Asphalt; Concrete Spreader; Elevator; Fork Lift (Home building only); Fork lift & Lulls; Fork Lift Walk Behind (Hoisting over 1 buck high); Form Line Machine; Grease Truck operator; Grout Pump; Gunnite Machine; Horizontal Directional Drill Locator; Single Drum Hoist with or without Tower; Huck Bolting Machine; Hydraulic Scaffold (Hoisting building materials); Paving Breaker (Self-propelled or Ridden); Pipe Dream; Pot Fireperson (Power Agitated); Refrigeration Plant; Road Widener; Roller; Sasgen Derrick; Seeding Machine; Soil Stabilizer (Pump type); Spray Cure Machine, Self-Propelled; Straw Blower Machine; Sub-Grader; Tube Finisher or Broom C.M.I. or similar type; & Tugger Hoist

GROUP 4 - Air Curtain Destructor & Similar Type; Batch Plant-Job Related; Boiler Operator; Compressor; Conveyor; Curb Builder, self-propelled; Drill Wagon; Generator Set; Generator-Steam; Heater-Portable Power; Hydraulic Manipulator Crane; Jack-Hydraulic Power driven; Jack-Hydraulic (Railroad); Ladavator; Minor Machine Operator; Mixer-Concrete; Mulching Machine; Pin Puller; Power Broom; Pulverizer; Pump; Road Finishing Machine (Pull Type); Saw-Concrete-Self-Propelled (Highway Work); Signal Person; Spray Cure Machine-Motor Powered; Stump Cutter; Tractor; Trencher Form; Water Blaster; Steam Jenny; Syphon; Vibrator-Gasoline; & Welding Machine

GROUP 5 - Brakeperson; Fireperson; & Oiler

IRON0017-002 05/01/2024

ASHTABULA (North of Route 6, starting at the Geauga County Line, proceeding east to State Route 45), CUYAHOGA, ERIE (Eastern 2/3), GEauga, HURON (East of a line drawn from the north border through Monroeville & Willard), LAKE, LORAIN, MEDINA (North of Old Rte. #224), PORTAGE (West of a line from Middlefield to Shalersville to Deerfield), and SUMMIT (North of Old Rte. #224, including city limits of Barberton) COUNTIES

Rates Fringes

IRONWORKER

Ornamental, Reinforcing, & Structural.....\$ 36.83 29.01

IRON0017-010 05/01/2024

ASHTABULA (Eastern part from Lake Erie on the north to route #322 on the south to include Conneaut, Kingsville, Sheffield, Denmark, Dorset, Cherry Valley, Wayne, Monroe, Pierpont, Richmond, Andover & Williamsfield Townships)

Rates Fringes

IRONWORKER

Structural, including metal building erection & Reinforcing.....\$ 36.83 29.01

IRON0044-001 06/01/2022

ADAMS (Western Part), BROWN, BUTLER (Southern Part), CLERMONT, CLINTON (South of a line drawn from Blanchester to Lynchburg), HAMILTON, HIGHLAND (Excluding eastern one-fifth & portion of county inside lines drawn from Marshall to Lynchburg from the northern county line through E. Monroe to Marshall) and WARREN (South of a line drawn from Blanchester through Morrow to the west county line) COUNTIES

Rates Fringes

IRONWORKER, REINFORCING.....\$ 32.37 22.30
Beyond 30-mile radius of Hamilton County Courthouse..\$ 28.67 21.20
Up to & including 30-mile radius of Hamilton County Courthouse.....\$ 27.60 20.70

IRON0044-002 06/01/2024

CLINTON (South of a line drawn from Blanchester to Lynchburg), HAMILTON, HIGHLAND (Excluding eastern one-fifth & portion of county inside lines drawn from Marshall to Lynchburg from the northern county line through E. Monroe to Marshall) & WARREN (South of a line drawn from Blanchester through Morrow to the west county line)

Rates Fringes

IRONWORKER

Fence Erector.....\$ 33.60 23.00
Ornamental; Structural.....\$ 35.37 23.00

IRON0055-003 07/01/2024

CRAWFORD (Area Between lines drawn from where Hwy #598 & #30 meet through N. Liberty to the northern border & from said Hwy junction point due west to the border), DEFIANCE (S. of a line drawn from where Rte. #66 meets the northern line through Independence to the eastern county border), ERIE (Western 1/3), FULTON, HANCOCK, HARDIN (North of a line drawn from Maysville to a point 4 miles south of the northern line on the eastern line), HENRY, HURON (West of a line drawn from the northern border through Monroeville & Willard), LUCAS, OTTAWA, PUTNAM (East of a line drawn from the northern border down through Miller City to where #696 meets the southern border), SANDUSKY, SENECA, WILLIAMS (East of a line drawn from Pioneer through Stryker to the southern border), WOOD & WYANDOT (North of Rte. #30)

	Rates	Fringes
IRONWORKER		
Fence Erector.....	\$ 26.40	24.62
Flat Road Mesh.....	\$ 29.77	21.30
Tunnels & Caissons Under Pressure.....	\$ 29.77	21.30
All Other Work.....	\$ 35.50	29.20

IRON0147-002 06/01/2024

ALLEN (Northern half), DEFIANCE (Northern part, excluding south of a line drawn from where Rte. #66 meets the northern line through Independence to the eastern county border), MERCER (Northern half), PAULDING, PUTNAM (Western part, excluding east of a line drawn from the northern border down through Miller City to where #696 meets the southern border), VAN WERT, and WILLIAMS (Western part, excluding east of a line drawn from Pioneer through Stryker to the southern border) COUNTIES

	Rates	Fringes
IRONWORKER.....	\$ 34.20	26.39

IRON0172-002 06/01/2024

CHAMPAIGN (Eastern one-third), CLARK (Eastern one-fourth), COSHOCTON (West of a line beginning at the northwestern county line going through Walhonding & Tunnel Hill to the southern county line), CRAWFORD (South of Rte. #30), DELAWARE, FAIRFIELD, FAYETTE, FRANKLIN, HARDIN (Excluding a line drawn from Roundhead to Maysville), HIGHLAND (Eastern one-fifth), HOCKING, JACKSON (Northern half), KNOX, LICKING, LOGAN (Eastern one-third), MADISON, MARION, MORROW, MUSKINGUM (West of a line starting at Adams Mill going to Adamsville & going from Adamsville through Blue Rock to the southern border), PERRY, PICKAWAY, PIKE (Northern half), ROSS, UNION, VINTON and WYANDOT (South of Rte. #30) COUNTIES

	Rates	Fringes
IRONWORKER.....	\$ 36.77	22.85

IRON0207-004 06/01/2024

ASHTABULA (Southern part starting at the Geauga County line), COLUMBIANA (E. of a line from Damascus to Highlandtown), MAHONING (N. of Old Route #224), PORTAGE (E. of a line from

Middlefield to Shalersville to Deerfield) & TRUMBULL

	Rates	Fringes
IRONWORKER		
Layout; Sheeter.....	\$ 35.83	27.41
Ornamental; Reinforcing; Structural.....	\$ 34.83	27.41
Ornamental; Reinforcing.....	\$ 28.92	25.61

IRON0290-002 06/01/2024

ALLEN (Southern half), AUGLAIZE, BUTLER (North of a line drawn from east to the west county line going through Oxford, Darrtown & Woodsdale), CHAMPAIGN (Excluding east of a line drawn from Catawla to the point where #68 intersects the northern county line), CLARK (Western two-thirds), CLINTON (Excluding south of a line drawn from Blanchester to Lynchburg), DARKE, GREENE, HIGHLAND (Inside lines drawn from Marshall to Lynchburg & from the northern county line through East Monroe to Marshall), LOGAN (West of a line drawn from West Liberty to where the northern county line meets the western county line of Hardin), MERCER (Southern half), MIAMI, MONTGOMERY, PREBLE, SHELBY & WARREN (Excluding south of a line drawn from Blanchester through Morrow to the western county line) COUNTIES

	Rates	Fringes
IRONWORKER.....	\$ 35.39	24.35

IRON0549-003 12/01/2022

BELMONT, GUERNSEY, HARRISON, JEFFERSON, MONROE & MUSKINGUM (Excluding portion west of a line starting at Adams Mill going to Adamsville and going from Adamsville through Blue Rock to the south border)

	Rates	Fringes
IRONWORKER.....	\$ 35.19	25.66

IRON0550-004 05/01/2024

ASHLAND, CARROLL, COLUMBIANA (W. of a line from Damascus to Highlandtown), COSHOCTON (E. of a line beginning at NW Co. line going through Walhonding & Tunnel Hill to the South Co. line), HOLMES, HURON (S. of Old Rte. #224), MAHONING (S. of Old Rte. #224), MEDINA (S. of Old Rte. #224), PORTAGE (S. of Old Rte. #224), RICHLAND, STARK, SUMMIT (S. of Old Rte. #224, Excluding city limits of Barberton), TUSCARAWAS, & WAYNE

	Rates	Fringes
Ironworkers:Structural, Ornamental and Reinforcing.....	\$ 34.70	22.88

IRON0769-004 06/01/2024

ADAMS (Eastern Half), GALLIA, JACKSON (Southern Half), LAWRENCE & SCIOTO

	Rates	Fringes
IRONWORKER.....	\$ 37.66	29.24

IRON0787-003 06/01/2024		

ATHENS, MEIGS, MORGAN, NOBLE, and WASHINGTON COUNTIES

	Rates	Fringes
IRONWORKER.....	\$ 33.00	24.25

LAB00265-008 05/01/2024		

	Rates	Fringes
LABORER		
ASHTABULA, ERIE, HURON, LORAIN, LUCAS, MAHONING, MEDINA, OTTAWA, PORTAGE, SANDUSKY, STARK, SUMMIT, TRUMBULL & WOOD COUNTIES		
GROUP 1.....	\$ 35.05	13.70
GROUP 2.....	\$ 35.22	13.70
GROUP 3.....	\$ 35.55	13.70
GROUP 4.....	\$ 36.00	13.70
CUYAHOGA AND GEAUGA COUNTIES ONLY: SEWAGE PLANTS, WASTE PLANTS, WATER TREATMENT FACILITIES, PUMPING STATIONS, & ETHANOL PLANTS		
CONSTRUCTION.....	\$ 37.66	13.70
CUYAHOGA, GEAUGA & LAKE COUNTIES		
GROUP 1.....	\$ 36.28	13.70
GROUP 2.....	\$ 36.45	13.70
GROUP 3.....	\$ 36.78	13.70
GROUP 4.....	\$ 37.23	13.70
REMAINING COUNTIES OF OHIO		
GROUP 1.....	\$ 35.52	14.45
GROUP 2.....	\$ 35.69	14.45
GROUP 3.....	\$ 36.02	14.45
GROUP 4.....	\$ 36.47	14.45

LABORER CLASSIFICATIONS

GROUP 1 - Asphalt Laborer; Carpenter Tender; Concrete Curing Applicator; Dump Man (Batch Truck); Guardrail and Fence Installer; Joint Setter; Laborer (Construction); Landscape Laborer; Mesh Handlers & Placer; Right-of-way Laborer; Riprap Laborer & Grouter; Scaffold Erector; Seal Coating; Surface Treatment or Road Mix Laborer; Sign Installer; Slurry Seal; Utility Man; Bridge Man; Handyman; Waterproofing Laborer; Flagperson; Hazardous Waste (level D); Diver Tender; Zone Person & Traffic Control

GROUP 2 - Asphalt Raker; Concrete Puddler; Kettle Man Pipeline); Machine Driven Tools (Gas, Electric, Air); Mason Tender; Brick Paver; Mortar Mixer; Power Buggy or Power Wheelbarrow; Paint Striper; Sheeting & Shoring Man; Surface Grinder Man; Plastic Fusing Machine Operator; Pug Mill Operator; & Vacuum Devices (wet or dry); Rodding Machine Operator; Diver; Screeman or Paver; Screed Person; Water Blast, Hand Held Wand; Pumps 4" & Under (Gas, Air or Electric) & Hazardous Waste (level C); Air Track and Wagon Drill; Bottom Person; Cofferdam (below 25 ft. deep);

Concrete Saw Person; Cutting with Burning Torch; Form Setter; Hand Spiker (Railroad); Pipelayer; Tunnel Laborer (without air) & Caisson; Underground Person (working in Sewer and Waterline, Cleaning, Repairing & Reconditioning); Sandblaster Nozzle Person; & Hazardous Waste (level B)

GROUP 3 - Blaster; Mucker; Powder Person; Top Lander; Wrencher (Mechanical Joints & Utility Pipeline); Yarner; Hazardous Waste (level A); Concrete Specialist; Concrete Crew in Tunnels (With Air-pressurized - \$1.00 premium); Curb Setter & Cutter; Grade Checker; Utility Pipeline Tapper; Waterline; and Caulker

GROUP 4 - Miner (With Air-pressurized - \$1.00 premium); & Gunite Nozzle Person

TUNNEL LABORER WITH AIR-PRESSURIZED ADD \$1.00 TO BASE RATE

SIGNAL PERSON WILL RECEIVE THE RATE EQUAL TO THE RATE PAID THE LABORER CLASSIFICATION FOR WHICH HE OR SHE IS SIGNALING.

PAIN006-002 05/01/2023

ASHTABULA, CUYAHOGA, GEauga, LAKE, LORAIN, PORTAGE (N. of the East-West Turnpike) & SUMMIT (N. of the East-West Turnpike)

Rates Fringes

PAINTER

COMMERCIAL NEW WORK; REMODELING; & RENOVATIONS		
GROUP 1.....	\$ 30.75	18.95
GROUP 2.....	\$ 31.15	18.95
GROUP 3.....	\$ 31.45	18.95
GROUP 4.....	\$ 37.01	18.95
COMMERCIAL REPAINT		
GROUP 1.....	\$ 29.25	18.95
GROUP 2.....	\$ 29.65	18.95
GROUP 3.....	\$ 29.95	18.95

PAINTER CLASSIFICATIONS - COMMERCIAL NEW WORK; REMODELING; & RENOVATIONS

GROUP 1 - Brush; & Roller

GROUP 2 - Sandblasting & Buffing

GROUP 3 - Spray Painting; Closed Steel Above 55 feet; Bridges & Open Structural Steel; Tanks - Water Towers; Bridge Painters; Bridge Riggers; Containment Builders

GROUP 4 - Bridge Blaster

PAINTER CLASSIFICATIONS - COMMERCIAL REPAINT

GROUP 1 - Brush; & Roller

GROUP 2 - Sandblasting & Buffing

GROUP 3 - Spray Painting

PAIN007-002 07/01/2024

FULTON, HENRY, LUCAS, OTTAWA (Excluding Allen, Bay, Bono,

Catawba Island, Clay Center, Curtice, Danbury, Eagle Beach, Elliston, Elmore, Erie, Fishback, Gem Beach & Genova) & WOOD

	Rates	Fringes
PAINTER		
NEW COMMERCIAL WORK		
GROUP 1.....	\$ 31.84	20.79
GROUP 2.....	\$ 32.84	20.79
GROUP 3.....	\$ 32.84	20.79
GROUP 4.....	\$ 32.84	20.79
GROUP 5.....	\$ 32.84	20.79
GROUP 6.....	\$ 32.84	20.79
GROUP 7.....	\$ 32.84	20.79
GROUP 8.....	\$ 32.84	20.79
GROUP 9.....	\$ 32.84	20.79

REPAINT IS 90% OF JR

PAINTER CLASSIFICATIONS

GROUP 1 - Brush; Spray & Sandblasting Pot Tender

GROUP 2 - Refineries & Refinery Tanks; Surfaces 30 ft. or over where material is applied to or labor performed on above ground level (exterior), floor level (interior)

GROUP 3 - Swing Stage & Chair

GROUP 4 - Lead Abatement

GROUP 5 - All Methods of Spray

GROUP 6 - Solvent-Based Catalized Epoxy Materials of 2 or More Component Materials, to include Solvent-Based Conversion Varnish (excluding water based)

GROUP 7 - Spray Solvent Based Material; Sand & Abrasive Blasting

GROUP 8 - Towers; Tanks; Bridges; Stacks Over 30 Feet

GROUP 9 - Epoxy Spray (excluding water based)

PAIN0012-008 05/01/2019

BUTLER COUNTY

	Rates	Fringes
PAINTER		
GROUP 1.....	\$ 21.95	10.20
GROUP 2.....	\$ 25.30	10.20
GROUP 3.....	\$ 25.80	10.20
GROUP 4.....	\$ 26.05	10.20
GROUP 5.....	\$ 26.30	10.20

PAINTER CLASSIFICATIONS

GROUP 1: Bridge Equipment Tender; Bridge/Containment Builder

GROUP 2: Brush & Roller

GROUP 3: Spray

GROUP 4: Sandblasting; & Waterblasting

GROUP 5: Elevated Tanks; Steeplejack Work; Bridge; & Lead Abatement

 PAIN0012-010 05/01/2019

BROWN, CLERMONT, CLINTON, HAMILTON & WARREN

	Rates	Fringes
PAINTER		
HEAVY & HIGHWAY BRIDGES- GUARDRAILS-LIGHTPOLES- STRIPING		
Bridge Equipment Tender and Containment Builder....	\$ 21.95	10.20
Bridges when highest point of clearance is 60 feet or more; & Lead		
Abatement Projects.....	\$ 26.30	10.20
Brush & Roller.....	\$ 25.30	10.20
Sandblasting & Hopper		
Tender; Water Blasting.....	\$ 26.05	10.20
Spray.....	\$ 25.80	10.20

 PAIN0093-001 12/01/2023

ATHENS, GUERNSEY, HOCKING, MONROE, MORGAN, NOBLE and
 WASHINGTON COUNTIES

	Rates	Fringes
PAINTER		
Bridges; Locks; Dams; Tension Towers; &		
Energized Substations.....	\$ 35.45	23.69
Power Generating Facilities.	\$ 32.30	23.69

 PAIN0249-002 05/01/2024

CLARK, DARKE, GREENE, MIAMI, MONTGOMERY & PREBLE

	Rates	Fringes
PAINTER		
GROUP 1 - Brush & Roller....	\$ 27.15	13.64
GROUP 2 - Swing, Scaffold Bridges; Structural Steel; Open Acid Tank; High Tension Electrical		
Equipment; & Hot Pipes.....	\$ 27.15	13.64
GROUP 3 - Spray; Sandblast; Steamclean;		
Lead Abatement.....	\$ 27.90	13.64
GROUP 4 - Steeplejack Work..	\$ 28.10	13.64
GROUP 5 - Coal Tar.....	\$ 28.65	13.64
GROUP 6 - Bridge Equipment Tender & or Containment Builder.....		
	\$ 35.86	13.64
GROUP 7 - Tanks, Stacks & Towers.....		
	\$ 31.09	13.64
GROUP 8 - Bridge Blaster, Rigger.....		
	\$ 38.86	13.64

PAIN0356-002 09/01/2009

KNOX, LICKING, MUSKINGUM, and PERRY

	Rates	Fringes
PAINTER		
Bridge Equipment Tenders and Containment Builders....	\$ 27.93	7.25
Bridges; Blasters; and Riggers.....	\$ 34.60	7.25
Brush and Roller.....	\$ 20.93	7.25
Sandblasting; Steam Cleaning; Waterblasting; and Hazardous Work.....	\$ 25.82	7.25
Spray.....	\$ 21.40	7.25
Structural Steel and Swing Stage.....	\$ 25.42	7.25
Tanks; Stacks; and Towers...	\$ 28.63	7.25

PAIN0438-002 12/01/2023

BELMONT, HARRISON and JEFFERSON COUNTIES

	Rates	Fringes
PAINTER		
Bridges, Locks, Dams, Tension Towers & Energized Substations.....	\$ 36.09	19.49
Power Generating Facilities.	\$ 32.94	19.49

PAIN0476-001 06/01/2024

COLUMBIANA, MAHONING, and TRUMBULL COUNTIES

	Rates	Fringes
PAINTER		
GROUP 1.....	\$ 28.39	17.14
GROUP 2.....	\$ 35.02	17.14
GROUP 3.....	\$ 28.60	17.14
GROUP 4.....	\$ 28.89	17.14
GROUP 5.....	\$ 29.04	17.14
GROUP 6.....	\$ 29.29	17.14
GROUP 7.....	\$ 30.39	17.14

PAINTER CLASSIFICATIONS:

GROUP 1: Painters, Brush & Roller

GROUP 2: Bridges

GROUP 3: Structural Steel

GROUP 4: Spray, Except Bar Joist/Deck

GROUP 5: Epoxy/Mastic; Spray- Bar Joist/Deck; Working Above
50 Feet; and Swingstages

GROUP 6: Tanks; Sandblasting

GROUP 7: Towers; Stacks

PAIN0555-002 11/01/2023

ADAMS, HIGHLAND, JACKSON, PIKE & SCIOTO

	Rates	Fringes
PAINTER		
GROUP 1.....	\$ 32.18	20.29
GROUP 2.....	\$ 33.81	20.29
GROUP 3.....	\$ 35.44	20.29
GROUP 4.....	\$ 38.63	20.29

PAINTER CLASSIFICATIONS

GROUP 1 - Containment Builder

GROUP 2 - Brush; Roller; Power Tools, Under 40 feet

GROUP 3 - Sand Blasting; Spray; Steam Cleaning; Pressure Washing; Epoxy & Two Component Materials; Lead Abatement; Hazardous Waste; Toxic Materials; Bulk & Storage Tanks of 25,000 Gallon Capacity or More; Elevated Tanks

GROUP 4 - Stacks; Bridges

PAIN0639-001 05/01/2011

	Rates	Fringes
Sign Painter & Erector.....	\$ 20.61	3.50+a+b+c

FOOTNOTES: a. 7 Paid Holidays: New Year's Day; Memorial Day; July 4th; Labor Day; Thanksgiving Day; Christmas Day & 1 Floating Day

b. Vacation Pay: After 1 year's service - 5 days' paid vacation; After 2, but less than 10 years' service - 10 days' paid vacation; After 10, but less than 20 years' service - 15 days' paid vacation; After 20 years' service - 20 days' paid vacation

c. Funeral leave up to 3 days maximum paid leave for death of mother, father, brother, sister, spouse, child, mother-in-law, father-in-law, grandparent and inlaw provided employee attends funeral

PAIN0788-002 06/01/2024

ASHLAND, CRAWFORD, ERIE, HANCOCK, HURON, MARION, MORROW, OTTAWA (Allen, Bay, Bono, Catawba Island, Clay Center, Curtice, Danbury, Eagle Beach, Elliston, Elmore, Erie, Fishback, Gem Beach & Genoa), RICHLAND, SANDUSKY, SENECA & WYANDOT

	Rates	Fringes
PAINTER		
Brush & Roller.....	\$ 29.13	17.52
Structural Steel.....	\$ 30.73	17.52

WINTER REPAINT: Between December 1 to March 31 - 90%JR

\$.50 PER HOUR SHALL BE ADDED TO THE RATE OF PAY FOR THE CLASSIFICATION OF WORK:

While working swingstage, boatswain chair, needle beam and horizontal cable. While operating sprayguns, sandblasting, cobblasting and high pressure waterblasting (4000psi).

\$1.00 PER HOUR SHALL BE ADDED TO THE RATE OF PAY FOR THE CLASSIFICATION OF WORK:

For the application of catalized epoxy, including latex epoxy that is deemed hazardous, lead abatement, or for work or material where special precautions beyond normal work duties must be taken. For working on stacks, tanks, and towers over 40 feet in height.

PAIN0813-005 12/01/2008

GALLIA, LAWRENCE, MEIGS & VINTON

	Rates	Fringes
PAINTER		
Base Rate.....	\$ 24.83	10.00
Bridges, Locks, Dams &		
Tension Towers.....	\$ 27.83	10.00

PAIN0841-001 06/01/2023

MEDINA, PORTAGE (South of and including Ohio Turnpike), and SUMMIT (South of and including Ohio Turnpike) COUNTIES

	Rates	Fringes
Painters:		
GROUP 1.....	\$ 30.18	15.50
GROUP 2.....	\$ 30.83	15.50
GROUP 3.....	\$ 30.93	15.50
GROUP 4.....	\$ 31.03	15.50
GROUP 5.....	\$ 31.43	15.50
GROUP 6.....	\$ 39.20	11.75
GROUP 7.....	\$ 31.68	15.50

PAINTER CLASSIFICATIONS:

GROUP 1 - Brush, Roller & Paperhanger

GROUP 2 - Epoxy Application

GROUP 3 - Swing Scaffold, Bosum Chair, & Window Jack

GROUP 4 - Spray Gun Operator of Any & All Coatings

GROUP 5 - Sandblast, Painting of Standpipes, etc. from Scaffolds, Bridge Work and/or Open Structural Steel, Standpipes and/or Water Towers

GROUP 6 - Public & Commerce Transportation, Steel or Galvanized, Bridges, Tunnels & Related Support Items (concrete)

GROUP 7 - Synthetic Exterior, Drywall Finisher and/or Taper, Drywall Finisher and Follow-up Man Using Automatic Tools

PAIN0841-002 06/01/2023

CARROLL, COSHOCTON, HOLMES, STARK, TUSCARAWAS & WAYNE

	Rates	Fringes
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PAINTER

Bridges; Towers, Poles &		
Stacks; Sandblasting		
Steel; Structural Steel &		
Metalizing.....	\$ 31.43	15.50
Brush & Roller.....	\$ 30.18	15.50
Spray; Tank Interior &		
Exterior.....	\$ 31.03	15.50

PAIN1020-002 07/01/2024

ALLEN, AUGLAIZE, CHAMPAIGN, DEFIANCE, HARDIN, LOGAN, MERCER,
PAULDING, PUTNAM, SHELBY, VAN WERT, and WILLIAMS COUNTIES

Rates Fringes

PAINTER

Brush & Roller.....	\$ 26.54	17.66
Drywall Finishing & Taping..	\$ 27.29	17.66
Lead Abatement.....	\$ 28.29	17.66
Spray, Sandblasting		
Pressure Cleaning, &		
Refinery.....	\$ 27.29	17.66
Swing Stage, Chair,		
Spiders, & Cherry Pickers...	\$ 26.79	17.66
Wallcoverings.....	\$ 27.29	17.66

All surfaces 40 ft. or over where material is applied to or
labor performed on, above ground level (exterior), floor
level (interior) - \$.50 premium

Applying Coal Tar Products - \$1.00 premium

PAIN1275-002 05/01/2024

DELAWARE, FAIRFIELD, FAYETTE, FRANKLIN, MADISON, PICKAWAY, ROSS
& UNION

Rates Fringes

PAINTER

Bridges.....	\$ 36.26	14.91
Brush; Roller.....	\$ 30.65	14.91
Sandblasting;		
Steamcleaning;		
Waterblasting (3500 PSI or		
Over)& Hazardous Work.....	\$ 31.35	14.91
Spray.....	\$ 31.15	14.91
Stacks; Tanks; & Towers.....	\$ 33.46	14.91
Structural Steel & Swing		
Stage.....	\$ 29.50	14.91

PLAS0109-001 06/01/2024

MEDINA, PORTAGE, STARK, and SUMMIT COUNTIES

Rates Fringes

PLASTERER.....	\$ 31.70	23.63
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PLAS0109-003 06/01/2024

CARROLL, HOLMES, TUSCARAWAS, and WAYNE COUNTIES

	Rates	Fringes
PLASTERER.....	\$ 31.70	23.63

PLAS0132-002 07/01/2024		

BROWN, BUTLER, CLERMONT, HAMILTON, HIGHLAND, WARREN COUNTIES

	Rates	Fringes
PLASTERER.....	\$ 30.40	16.54

PLAS0404-002 05/01/2018		

ASHTABULA, CUYAHOGA, GEAUGA, AND LAKE COUNTIES

	Rates	Fringes
PLASTERER.....	\$ 29.63	17.11

PLAS0404-003 05/01/2018		

LORAIN COUNTY

	Rates	Fringes
PLASTERER.....	\$ 28.86	17.11

PLAS0526-022 05/01/2018		

COLUMBIANA, MAHONING, and TRUMBULL COUNTIES

	Rates	Fringes
PLASTERER.....	\$ 28.86	17.11

PLAS0526-023 05/01/2018		

BELMONT, HARRISON, and JEFFERSON COUNTIES

	Rates	Fringes
PLASTERER.....	\$ 28.21	17.11

PLAS0886-001 07/01/2024		

FULTON, HANCOCK, HENRY, LUCAS, PUTNAM, and WOOD COUNTIES

	Rates	Fringes
PLASTERER.....	\$ 33.73	23.25

PLAS0886-003 07/01/2024		

	Rates	Fringes
PLASTERER.....	\$ 33.73	23.25

PLAS0886-004 07/01/2024		

	Rates	Fringes
PLASTERER.....	\$ 33.73	23.25

PLUM0042-002 07/01/2024		

ASHLAND, CRAWFORD, ERIE, HURON, KNOX, LORAIN, MORROW, RICHLAND

& WYANDOT

Rates Fringes

Plumber, Pipefitter,
Steamfitter.....\$ 40.62 25.67

PLUM0050-002 07/01/2024

DEFIANCE, FULTON, HANCOCK, HENRY, LUCAS, OTTAWA, PAULDING,
PUTNAM, SANDUSKY, SENECA, WILLIAMS & WOOD

Rates Fringes

Plumber, Pipefitter,
Steamfitter.....\$ 49.70 30.76

PLUM0055-003 05/01/2024

ASHTABULA, CUYAHOGA, GEAUGA, LAKE, MEDINA (N. of Rte. #18 &
Smith Road) & SUMMIT (N. of Rte. #303, including the corporate
limits of the city of Hudson)

Rates Fringes

PLUMBER.....\$ 42.36 29.90

PLUM0083-001 07/01/2023

BELMONT & MONROE (North of Rte. #78)

Rates Fringes

Plumber and Steamfitter.....\$ 35.94 37.35

* PLUM0094-002 05/01/2024

CARROLL (Northen Half), STARK, and WAYNE COUNTIES

Rates Fringes

PLUMBER/PIPEFITTER.....\$ 45.23 24.89

PLUM0120-002 04/29/2024

ASHTABULA, CUYAHOGA, GEAUGA, LAKE, LORAIN (the C.E.I. Power
House in Avon Lake), MEDINA (N. of Rte. #18) & SUMMIT (N. of
#303)

Rates Fringes

PIPEFITTER.....\$ 47.07 28.15

PLUM0162-002 06/01/2024

CHAMPAIGN, CLARK, CLINTON, DARKE, FAYETTE, GREENE, MIAMI,
MONTGOMERY & PREBLE

Rates Fringes

Plumber, Pipefitter,
Steamfitter.....\$ 43.05 27.18

PLUM0168-002 06/01/2024

MEIGS, MONROE (South of Rte. #78), MORGAN (South of Rte. #78)
& WASHINGTON

	Rates	Fringes
PLUMBER/PIPEFITTER.....	\$ 39.43	37.29

PLUM0189-002 06/01/2024

DELAWARE, FAIRFIELD, FRANKLIN, HOCKING, LICKING, MADISON,
MARION, PERRY, PICKAWAY, ROSS & UNION

	Rates	Fringes
Plumber, Pipefitter, Steamfitter.....	\$ 43.25	26.94

PLUM0219-002 06/01/2024

MEDINA (Rte. #18 from eastern edge of Medina Co., west to
eastern corporate limits of the city of Medina, & on the county
road from the west corporate limits of Medina running due west
to and through community of Risley to the western edge of
Medina County - All territory south of this line), PORTAGE, and
SUMMIT (S. of Rte. #303) COUNTIES

	Rates	Fringes
Plumber and Steamfitter.....	\$ 45.37	27.64

PLUM0392-002 06/01/2024

BROWN, BUTLER, CLERMONT, HAMILTON & WARREN

	Rates	Fringes
PLUMBER/PIPEFITTER.....	\$ 40.65	26.75

PLUM0396-001 06/01/2024

COLUMBIANA (Excluding Washington & Yellow Creek Townships &
Liverpool Twp. - Secs. 35 & 36 - West of County Road #427),
MAHONING and TRUMBULL COUNTIES

	Rates	Fringes
PLUMBER/PIPEFITTER.....	\$ 38.45	28.96

PLUM0495-002 06/01/2024

CARROLL (Rose, Monroe, Union, Lee, Orange, Perry & Loudon
Townships), COLUMBIANA (Washington & Yellow Creek Townships &
Liverpool Township, Secs. 35 & 36, West of County Rd. #427),
COSHOCOTON, GUERNSEY, HARRISON, HOLMES, JEFFERSON, MORGAN (South
to State Rte. #78 & from McConnelville west on State Rte. #37
to the Perry County line), MUSKINGUM, NOBLE, and TUSCARAWAS
COUNTIES

	Rates	Fringes
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Plumber, Pipefitter,
 Steamfitter.....\$ 37.82 36.70

 PLUM0577-002 06/01/2024

ADAMS, ATHENS, GALLIA, HIGHLAND, JACKSON, LAWRENCE, PIKE,
 SCIOTO & VINTON

Rates Fringes

Plumber, Pipefitter,
 Steamfitter.....\$ 41.65 27.48

 PLUM0776-002 07/01/2024

ALLEN, AUGLAIZE, HARDIN, LOGAN, MERCER, SHELBY and VAN WERT
 COUNTIES

Rates Fringes

Plumber, Pipefitter,
 Steamfitter.....\$ 42.07 29.35

 TEAM0377-003 05/01/2024

STATEWIDE, EXCEPT CUYAHOGA, GEAUGA & LAKE

Rates Fringes

TRUCK DRIVER
 GROUP 1.....\$ 32.54 16.80
 GROUP 2.....\$ 32.96 16.80

TRUCK DRIVER CLASSIFICATIONS

GROUP 1 - Asphalt Distributor; Batch; 4- Wheel Service;
 4-Wheel Dump; Oil Distributor & Tandem

GROUP 2 - Tractor-Trailer Combination: Fuel; Pole Trailer;
 Ready Mix; Semi-Tractor; & Asphalt Oil Spraybar Man When
 Operated From Cab; 5 Axles & Over; Belly Dump; End Dump;
 Articulated Dump; Heavy Duty Equipment; Low Boy; & Truck
 Mechanic

 TEAM0436-002 05/01/2024

CUYAHOGA, GEAUGA & LAKE

Rates Fringes

TRUCK DRIVER
 GROUP 1.....\$ 32.25 18.95
 GROUP 2.....\$ 33.75 18.95

GROUP 1: Straight & Dump, Straight Fuel

GROUP 2: Semi Fuel, Semi Tractor, Euclids, Darts, Tank,
 Asphalt Spreaders, Low Boys, Carry-All, Tourna-Rockers,
 Hi-Lifts, Extra Long Trailers, Semi-Pole Trailers, Double
 Hook-Up Tractor Trailers including Team Track & Railroad
 Siding, Semi-Tractor & Tri-Axle Trailer, Tandem Tractor &
 Tandem Trailer, Tag Along Trailer, Expandable Trailer or
 Towing Requiring Road Permits, Ready-Mix (Agitator or

Non-Agitator), Bulk Concrete Driver, Dry Batch Truck,
Articulated End Dump

WELDERS - Receive rate prescribed for craft performing
operation to which welding is incidental.

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** Workers in this classification may be entitled to a higher
minimum wage under Executive Order 14026 (\$17.20) or 13658
(\$12.90). Please see the Note at the top of the wage
determination for more information. Please also note that the
minimum wage requirements of Executive Order 14026 are not
currently being enforced as to any contract or subcontract to
which the states of Texas, Louisiana, or Mississippi, including
their agencies, are a party.

Note: Executive Order (EO) 13706, Establishing Paid Sick Leave
for Federal Contractors applies to all contracts subject to the
Davis-Bacon Act for which the contract is awarded (and any
solicitation was issued) on or after January 1, 2017. If this
contract is covered by the EO, the contractor must provide
employees with 1 hour of paid sick leave for every 30 hours
they work, up to 56 hours of paid sick leave each year.
Employees must be permitted to use paid sick leave for their
own illness, injury or other health-related needs, including
preventive care; to assist a family member (or person who is
like family to the employee) who is ill, injured, or has other
health-related needs, including preventive care; or for reasons
resulting from, or to assist a family member (or person who is
like family to the employee) who is a victim of, domestic
violence, sexual assault, or stalking. Additional information
on contractor requirements and worker protections under the EO
is available at
<https://www.dol.gov/agencies/whd/government-contracts>.

Unlisted classifications needed for work not included within
the scope of the classifications listed may be added after
award only as provided in the labor standards contract clauses
(29CFR 5.5 (a) (1) (iii)).

The body of each wage determination lists the classification
and wage rates that have been found to be prevailing for the
cited type(s) of construction in the area covered by the wage
determination. The classifications are listed in alphabetical
order of ""identifiers"" that indicate whether the particular
rate is a union rate (current union negotiated rate for local),
a survey rate (weighted average rate) or a union average rate
(weighted union average rate).

Union Rate Identifiers

A four letter classification abbreviation identifier enclosed
in dotted lines beginning with characters other than ""SU"" or
""UAVG"" denotes that the union classification and rate were
prevailing for that classification in the survey. Example:
PLUM0198-005 07/01/2014. PLUM is an abbreviation identifier of
the union which prevailed in the survey for this
classification, which in this example would be Plumbers. 0198
indicates the local union number or district council number
where applicable, i.e., Plumbers Local 0198. The next number,

005 in the example, is an internal number used in processing the wage determination. 07/01/2014 is the effective date of the most current negotiated rate, which in this example is July 1, 2014.

Union prevailing wage rates are updated to reflect all rate changes in the collective bargaining agreement (CBA) governing this classification and rate.

Survey Rate Identifiers

Classifications listed under the ""SU"" identifier indicate that no one rate prevailed for this classification in the survey and the published rate is derived by computing a weighted average rate based on all the rates reported in the survey for that classification. As this weighted average rate includes all rates reported in the survey, it may include both union and non-union rates. Example: SULA2012-007 5/13/2014. SU indicates the rates are survey rates based on a weighted average calculation of rates and are not majority rates. LA indicates the State of Louisiana. 2012 is the year of survey on which these classifications and rates are based. The next number, 007 in the example, is an internal number used in producing the wage determination. 5/13/2014 indicates the survey completion date for the classifications and rates under that identifier.

Survey wage rates are not updated and remain in effect until a new survey is conducted.

Union Average Rate Identifiers

Classification(s) listed under the UAVG identifier indicate that no single majority rate prevailed for those classifications; however, 100% of the data reported for the classifications was union data. EXAMPLE: UAVG-OH-0010 08/29/2014. UAVG indicates that the rate is a weighted union average rate. OH indicates the state. The next number, 0010 in the example, is an internal number used in producing the wage determination. 08/29/2014 indicates the survey completion date for the classifications and rates under that identifier.

A UAVG rate will be updated once a year, usually in January of each year, to reflect a weighted average of the current negotiated/CBA rate of the union locals from which the rate is based.

State Adopted Rate Identifiers

Classifications listed under the ""SA"" identifier indicate that the prevailing wage rate set by a state (or local) government was adopted under 29 C.F.R. 1.3(g)-(h). Example: SAME2023-007 01/03/2024. SA reflects that the rates are state adopted. ME refers to the State of Maine. 2023 is the year during which the state completed the survey on which the listed classifications and rates are based. The next number, 007 in the example, is an internal number used in producing the wage determination. 01/03/2024 reflects the date on which the classifications and rates under the ?SA? identifier took effect under state law in the state from which the rates were adopted.

WAGE DETERMINATION APPEALS PROCESS

1.) Has there been an initial decision in the matter? This can be:

- * an existing published wage determination
- * a survey underlying a wage determination
- * a Wage and Hour Division letter setting forth a position on a wage determination matter
- * a conformance (additional classification and rate) ruling

On survey related matters, initial contact, including requests for summaries of surveys, should be with the Wage and Hour National Office because National Office has responsibility for the Davis-Bacon survey program. If the response from this initial contact is not satisfactory, then the process described in 2.) and 3.) should be followed.

With regard to any other matter not yet ripe for the formal process described here, initial contact should be with the Branch of Construction Wage Determinations. Write to:

Branch of Construction Wage Determinations
Wage and Hour Division
U.S. Department of Labor
200 Constitution Avenue, N.W.
Washington, DC 20210

2.) If the answer to the question in 1.) is yes, then an interested party (those affected by the action) can request review and reconsideration from the Wage and Hour Administrator (See 29 CFR Part 1.8 and 29 CFR Part 7). Write to:

Wage and Hour Administrator
U.S. Department of Labor
200 Constitution Avenue, N.W.
Washington, DC 20210

The request should be accompanied by a full statement of the interested party's position and by any information (wage payment data, project description, area practice material, etc.) that the requestor considers relevant to the issue.

3.) If the decision of the Administrator is not favorable, an interested party may appeal directly to the Administrative Review Board (formerly the Wage Appeals Board). Write to:

Administrative Review Board
U.S. Department of Labor
200 Constitution Avenue, N.W.
Washington, DC 20210

4.) All decisions by the Administrative Review Board are final.

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END OF GENERAL DECISION"