

**TOWN OF LISBON WATER DEPARTMENT
CONTRACT#2 BISHOP ROAD WELL IMPROVEMENTS
USDA WEP, ARPA #1361010, DWSRF#1361010, DWGT-82
COMMUNITY DEVELOPMENT BLOCK GRANT
LISBON, NEW HAMPSHIRE**

ADDENDUM #4

DATE: September 3, 2026
TO: ALL PLAN HOLDERS

This ADDENDUM #4 shall become part of the Bidding Documents, Contract Documents and Technical Specifications (Documents) for the above referenced project. BIDDERS, please acknowledge receipt of this ADDENDUM #4 on the BID FORM (Page 1). This ADDENDUM #4 consists of 86 page in total.

1. New Bid Specifications

Replaced the Division 26 Electrical Specifications with the attached.

Section 26 3213 Engine Generators

Section 26 3623.16 Automatic/Nonautomatic Transfer Switches

2. Revised Specifications

Revised Specification 33 09 00 PLC and SCADA Control Systems

Revised Specification 33 09 01 Instrumentation and Control Systems

3. Bid Plans

Attached to this addendum are the revised Electrical Drawings

Attached:

Section 26 0001 Electrical Systems

Section 26 3213 Engine Generators

Section 26 3623.16 Automatic/Nonautomatic Transfer Switches

Section 33 09 00 PLC and SCADA Control Systems

Section 33 09 01 Instrumentation and Control Systems

Drawing C3.1 Plan & Profile Sewer Forcemain STA 5+50 to STA 11+96.35

Drawing E1 Electrical Legend and General Notes

Drawing E2 Electrical Site Power Plan and Details

End of Addendum #4

**SECTION 26 0001
ELECTRICAL SYSTEMS**

PART 1 GENERAL

1.01 WORK INCLUDED

- A. Complying with the applicable provisions of the General Conditions, Supplementary Conditions, Special State Conditions and other provisions of the Contract Documents that apply to the Work included in Division 26. The general provisions of the Contract, including the General, Supplementary, and Special Conditions and the General Requirements apply to the work specified in all sections of this Division.
- B. The work required of this Division shall include all labor, materials, equipment, plant, transportation and all necessary and related items required to provide complete and satisfactory operating electrical systems for the project. Install new electrical systems including but not limited to: selective demolition, power distribution, electrical devices and receptacles, lighting, emergency lighting, exit signs, panelboard, fire alarm modifications, branch circuit wiring, Cat 6e cables, switching, grounding, and power systems for the HVAC system upgrades and additions/modifications.
- C. Existing classroom and existing building lighting. Remove existing classroom, corridor, bathroom, kitchen and storage room lighting fixtures and properly dispose of them. Refer to Architectural Plans.
 - 1. Provide new high performance bi-level fixtures in all areas as indicated. The intent is to reuse the existing branch circuits that serve the existing spaces. Reuse the existing switches and provide new cover plates for any devices that are damaged or rusted with new nylon (ivory) device covers matching existing.
 - 2. Provide occupancy sensors in all areas indicated. Coordinate with Architect/Engineer on sequence of operation during Shop Drawing review.
 - 3. All existing wall switches, exit signs, emergency battery units and related life safety devices to remain unless otherwise indicated.
 - 4. Relocate all ceiling mounted fire alarm, speakers and related electrical devices from existing ceilings to new. Extend wiring as needed.
 - 5. All new 120v wiring shall be in conduit (EMT) or MC cable as accepted by the Engineer.
 - 6. Contractor must take precautions in his demolition to maintain existing switch legs to afford the reuse of the existing switches for the new fixture control.
- D. The work in general includes, but is not limited to, the following:
 - 1. Wire and Cable.
 - 2. Wiring devices, raceways, boxes and fittings.
 - 3. Branch circuits to all electrical equipment.
 - 4. Panelboard and circuit breakers.
 - 5. Disconnect switches and fuses.
 - 6. Lighting system, fixtures and accessories.
 - 7. Final connections to all equipment furnished by this Division and by other Divisions.
 - 8. Grounding and bonding
 - 9. Receiving, handling and storage of all equipment required of this Division
 - 10. Mounting of equipment furnished by other trades, if so designated
 - 11. The final testing and adjustment of all electrical systems and equipment to demonstrate proper function, control and interlock.
 - 12. All minor and related items and accessories to make each system complete in all respects.
- E. Drawings: contract drawings for electrical work are in part diagrammatic, intended to convey scope of work and indicate the general arrangement of equipment. Electrical trade shall follow these drawings in laying out their work, consult general construction drawings to familiarize

themselves with conditions affecting their work, and shall verify spaces in which their work will be installed by measurements on the job. Do not scale drawings.

- F. Coordinate all work activities with the Owner.
- G. CONTRACTOR shall coordinate with OWNER when any shutdowns or power outages are required. Failure to do so, and any subsequent expenses due to failure, shall be the responsibility of the CONTRACTOR.
- H. CONTRACTOR shall coordinate with utilities, and the Owner or any other customers affected by work. Failure to do so, and any subsequent expenses due to failure, shall be the responsibility of the CONTRACTOR.
- I. Coordinate with the utility .
- J. Coordination with local fire department prior to installation of any fire alarm devices.
- K. Throughout construction CONTRACTOR shall provide upgraded schedules to accurately reflect time frame of work.
- L. Complying with requirements of all codes and regulatory agencies.
- M. Arranging for and paying all fees for permits and observations.
- N. Installing equipment furnished by others:
 - 1. Installing and connecting electrically operated equipment, cabinets, starters, controls and related items furnished under other Divisions.
 - 2. Installing conduit and wiring as required for such equipment.
- O. Installing and connecting electrically operated equipment, cabinets, starters, controls and related items furnished under other Divisions or furnished under this Division. Installing conduit and wiring as required for such equipment. Complying with the applicable provisions of the General Conditions, Supplementary Conditions, Special State Conditions and other provisions of the Contract Documents that apply to the Work included in Division 26.

1.02 COORDINATION WITH UTILITY COMPANY

- A. The public service company is: Green Mountain Power (GMP)
- B. Utility back charges will be paid by OWNER.
- C. Work under this section shall be closely coordinated with related work of the local utility company and shall be in accordance with requirements set forth hereby.
- D. Submit Drawings and Specifications indicating work to be accomplished and obtain approval from the local utility company.

1.03 NOT INCLUDED

- A. Digging, backfilling, blasting, pumping, shoring, concrete and work furnished by other trades.
- B. Furnishing and/or installing temperature control for mechanical trades.
- C. Furnishing and/or installing control devices for mechanical trades unless specified herein or on the Drawings.
- D. Work specifically indicated to be done by OWNER or others.

1.04 REFERENCE STANDARDS

29 CFR 1910.145 - ACCIDENT PREVENTION SIGNS AND TAGS; CURRENT EDITION.

NECA 1 - STANDARD FOR GOOD WORKMANSHIP IN ELECTRICAL CONSTRUCTION; 2023.

NEMA BS 31047 - HEAVY DUTY ENCLOSED AND DEAD-FRONT SWITCHES (600 VOLTS MAXIMUM); 2013 (REAFFIRMED 2023).

NEMA EN 10250 - ENCLOSURES FOR ELECTRICAL EQUIPMENT (1000 VOLTS MAXIMUM); 2024.

NEMA FU 1 - LOW VOLTAGE CARTRIDGE FUSES; 2012.

NEMA ICS 2 - INDUSTRIAL CONTROL AND SYSTEMS CONTROLLERS, CONTACTORS AND OVERLOAD RELAYS RATED 600 VOLTS; 2008 (REAFFIRMED 2020).

NEMA PB 1 - PANELBOARDS; 2011.

NEMA ST 20 - DRY TYPE TRANSFORMERS FOR GENERAL APPLICATIONS; 2021.

NEMA WD 1 - GENERAL COLOR REQUIREMENTS FOR WIRING DEVICES; 1999 (REAFFIRMED 2020).

NEMA WD 6 - WIRING DEVICES - DIMENSIONAL SPECIFICATIONS; 2021.

NFPA 70 - NATIONAL ELECTRICAL CODE; MOST RECENT EDITION ADOPTED BY AUTHORITY HAVING JURISDICTION, INCLUDING ALL APPLICABLE AMENDMENTS AND SUPPLEMENTS.

UL 20 - GENERAL-USE SNAP SWITCHES; CURRENT EDITION, INCLUDING ALL REVISIONS.

UL 498 - ATTACHMENT PLUGS AND RECEPTACLES; CURRENT EDITION, INCLUDING ALL REVISIONS.

UL 943 - GROUND-FAULT CIRCUIT-INTERRUPTERS; CURRENT EDITION, INCLUDING ALL REVISIONS.

UL 1472 - SOLID-STATE DIMMING CONTROLS; CURRENT EDITION, INCLUDING ALL REVISIONS.

UL 1561 - STANDARD FOR DRY-TYPE GENERAL PURPOSE AND POWER TRANSFORMERS; CURRENT EDITION, INCLUDING ALL REVISIONS.

- A. Electrical work shall conform to all requirements of:
 - 1. National Electric Code NEC
 - 2. State Building Codes.
 - 3. Local ordinances and regulations.
 - 4. NFPA Fire Codes, current edition.
 - 5. Underwriters' Laboratories standards.
 - 6. Local utility company requirements.
- B. It shall be understood that all codes and standards mentioned shall be those in force at the time the Contract is signed. If any code is changed during the construction period, these Specifications may be changed by mutual agreement between the ENGINEER and CONTRACTOR.

1.05 QUALITY ASSURANCE

- A. Codes and standards
 - 1. Comply with National Electrical Code requirements for electrical materials and installations.
 - 2. KEEP COPY OF NATIONAL ELECTRICAL CODE IN FIELD OFFICE FOR DURATION OF PROJECT.
 - 3. In each case, codes are minimum requirements.
- B. The CONTRACTOR shall submit proof that the items which he proposes to furnish under this specification conform to the standards of Underwriters Laboratories, Inc. (UL), Factory Mutual Engineering Corp. (FM) or Warnock Hersey Inc. (WH). The labels of these three organizations shall be accepted as conforming to this requirement. In lieu of the label, the CONTRACTOR may submit a written certification from any nationally recognized testing agency, adequately equipped and competent to perform such services, that the item has been tested and conforms to the standards including methods of test, or the testing organization(s).
- C. Qualifications of installers:
 - 1. For the actual fabrication, installation and testing of the work of this Section use only thoroughly trained and experienced personnel who are completely familiar with the requirements for this work and with the installation recommendations of the manufacturers

of the specified items. CONTRACTOR shall be one that is regularly engaged in this type of work.

2. In the acceptance or rejection of the installed electrical system, no allowance will be made for lack of skill on the part of installers.
3. The CONTRACTOR shall not be relieved from complying with any of the requirements of the Specifications or Drawings which may be in excess of and not contrary to the requirements of the above mentioned rules.

D. Observation certificates:

1. Deliver to the ENGINEER two (2) copies of the Electrical Inspector's certificate of approval showing acceptability of work done under this Contract.
2. Deliver to the ENGINEER two (2) copies of any other certificates of approval.

1.06 SUBMITTALS

- A. Submit complete catalog information and shop drawings for all materials and equipment. Copies of all documents shall be provided to the ENGINEER for approval (number of copies per submittals section). In general, those items include but are not limited to the following:
1. Disconnect Switches.
 2. Panelboards
 3. Wiring devices including receptacles, switches, and device covers.
 4. Wire and cables.
 5. Conduits.
 6. Lighting fixtures and controls
 7. Fire alarm devices.
- B. All shop drawings shall be checked for accuracy and contract requirements before the submittal to the ENGINEER. Shop drawings shall bear the signature of the CONTRACTOR and date checked, and shall be accompanied by a statement that the Drawings have been examined for conformity to Specifications and Drawings. This statement shall also list all discrepancies with the Specifications and Drawings. Shop drawings not so checked and noted by the CONTRACTOR will be returned to him without approval.
- C. The ENGINEER'S review will be only for conformance with the design concept of the project and compliance with the Specifications and Contract Drawings. The ENGINEER'S approval shall in no way relieve the CONTRACTOR from the responsibility of, or the necessity of, furnishing materials and workmanship required by the Contract Drawings and Specifications which may not be indicated on the shop drawings.
- D. All such equipment and materials installed without the approval of the ENGINEER shall be subject to removal and shall be replaced with materials so accepted by the ENGINEER, at the CONTRACTOR'S expense.
- E. Right to Reject: Unless otherwise expressly provided in the Contract Documents the means and methods of construction, including all safety procedures, shall be such as the Contractor may choose, subject however, to the Engineer's right to reject means and methods proposed by the Contractor which (1) will constitute or create a hazard to the work, person(s) or property or (2) will not produce finished work in accordance with the terms of the Contract. The right to reject shall not, in any way, be construed or interpreted as acceptance or control of means and methods by the Engineer and/or his representative.
- F. Contractor's Obligations: The Engineer's rejection of the Contractor's means and methods or construction, or the Engineer's failure to exercise his right to reject such means or methods, shall not relieve the Contractor of his obligation to accomplish the result intended by the Contract: nor shall the retention of such right-to-reject create a cause of action for damages due to exercise, or failure to exercise, such rights.

1.07 SUBSTITUTIONS

- A. No substitutions shall be made without written approval from the OWNER.

- B. Submit complete information to demonstrate that proposed substitution is equal in construction and performance to the specified item. Otherwise, the substitution will be rejected. Samples shall be submitted if requested.
- C. The Contract price addition or deduction shall be indicated.
- D. The CONTRACTOR is responsible for insuring that substitute items will fit into available space and for any extra charges by other trades.

1.08 FINAL SUBMITTALS

- A. Project record documents:
 - 1. During progress of the Work, maintain an accurate record of the installation of the electrical system, locating each circuit precisely by dimensions.
 - 2. Upon completion of the electrical installation, transfer all record data to prints of the original Drawings. Deliver to the ENGINEER one copy of these prints.
- B. As a requisite for final acceptance, the following are required:
 - 1. Deliver to the ENGINEER two (2) copies of the Electrical Inspector's Certificate of Approval showing acceptability of work done under this Contract for presentation to the OWNER.
 - 2. Deliver to the ENGINEER two (2) copies of any other Certificates of Approval for presentation to the OWNER.
 - 3. Contractor shall assemble four (4) maintenance and operating manuals containing the following items.
 - a. accepted Shop Drawing Submittals for all electrical equipment.
 - b. Name address and telephone number of manufacturer or manufacturer's representative for each piece of electrical equipment. Name shall include a specific contact person.
 - c. Troubleshooting guides and maintenance manuals for each piece of electrical equipment.
 - d. List of recommended spare parts for each piece of electrical equipment.
 - e. A single matrix or chart detailing specific operating procedures and operating sequences for all pieces of electrical equipment.
 - f. Maintenance manuals shall be assembled in three ring binders. Binders shall not be filled more than 75% of capacity. Provide as many binders as required.
 - g. Each specific piece of electrical equipment along with its accompanying information shall be separately tabbed within the binder. Tabs shall be arranged in alphabetical order.
 - h. The spine of each binder shall be labeled with "Maintenance and Operating Manual - Book _ of _". The front cover shall have the same information as the spine. Additionally, the front cover shall identify the project name and date of final acceptance by the Owner. Also identified shall be the name, address and telephone number of the contractor responsible for the electrical work, and the name, address, and telephone number of the electrical engineer.

1.09 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. Protection: Use all means necessary to protect electrical system materials before, during and after installation and to protect the installed work and materials of all other trades.
- B. Replacements: In the event of damage, immediately make all repairs and replacements necessary to the acceptance of the ENGINEER and at no additional cost to the OWNER. If any apparatus has been subject to possible injury by water, it shall be thoroughly dried out and put through such special tests as directed by the ENGINEER at the cost and expense of the CONTRACTOR, or shall be replaced by the CONTRACTOR at his own expense.
- C. Protect the work of other trades. Restore any damage caused to other trades to the condition existing prior to damage at no additional cost to the OWNER.

- D. Investigate each space in the building through which equipment must pass to reach its final location. If necessary, the manufacturer shall be required to ship his material in sections sized to permit passing through such restricted areas in the building.

1.10 PROJECT CONDITIONS

- A. Project description:
 - 1. The project is to provide all electrical equipment necessary to provide a complete and working system. Provide all labor, materials, equipment, appliances and tools and perform all work necessary for the complete execution of the electrical work as shown on the Drawings, required by the Specifications and work not specifically shown or specified, yet required to insure proper and complete operation of all systems and to satisfy the design intent inherent in the Work and to comply with all applicable codes and regulations.
 - 2. All material removed including conduit, wire and related electrical equipment is to be disposed of by the CONTRACTOR in a legal manner that complies with all rules and regulations applicable in the state.
- B. Existing conditions:
 - 1. Prior to all work of this Section, carefully observe the installed work of all other trades and verify that all such work is complete to the point where this installation may properly commence.
 - 2. Verify that the electrical installation may be made in complete accordance with all pertinent codes and regulations and the design. In the event of discrepancy, immediately notify the ENGINEER. Do not proceed with installation in areas of discrepancy until all such discrepancies have been fully resolved.
 - 3. Verify sizes and ratings of motors and other electrically operated devices supplied by others.
- C. Coordination:
 - 1. Coordinate the installation of electrical items with the schedules for work of other trades to prevent unnecessary delays in the total work.
 - 2. Any changes shall be done at the CONTRACTOR'S expense.
 - 3. Where electrical items are shown in conflict with locations of structural members and mechanical or other equipment, furnish and install all required supports and wiring to clear the encroachment.
 - 4. Any work installed contrary to or without acceptance by the ENGINEER shall be subject to change as directed by the ENGINEER, and no extra compensation will be allowed the CONTRACTOR for making these changes.
- D. Accuracy of data:
 - 1. The Drawings are diagrammatic and functional only, and are not intended to show exact circuit layouts, number of fittings, or other installation details.
 - 2. Locations are approximate only and field measurements govern. Where conflicts or interferences occur, consult with ENGINEER before installation.

1.11 DEFINITIONS

- A. General: Basic Contract definitions are included in the Conditions of the Contract.
- B. Indicated: The term 'indicated' refers to graphic representations, notes, or schedules on the Drawings, or other Paragraphs or Schedules in the Specifications, and similar requirements in the Contract Documents. Where terms such as shown, noted scheduled and specified are used it is to help the reader locate the reference; no limitation on location is intended.
- C. Directed: Terms such as directed, requested, authorized, selected, accepted, required and permitted mean directed by the ENGINEER, requested by the ENGINEER and similar phrases.
- D. Accept: The term accepted, when used in conjunction with the ENGINEER'S action on the CONTRACTOR'S submittals, applications and requests, is limited to the ENGINEER'S duties and responsibilities as stated in the Conditions of the Contract.

- E. Regulations: The term Regulations includes laws, ordinances, statutes and lawful orders issued by authorities having jurisdiction, as well as rules, conventions and agreements within the construction industry that control performance of the Work.
- F. Furnish: The term 'furnish' is used to mean 'supply and deliver to the Project Site, ready for unloading, unpacking, assembly, installation and similar operations.'
- G. Install: The term install is used to describe operations at the Project Site including the actual unloading, unpacking, assembly, erection, placing, anchoring, applying, working to dimension, finishing, curing, protecting, cleaning and similar operations.
- H. Provide: The term provide means to furnish and install, complete and ready for the intended use.
- I. Installer: An Installer is the CONTRACTOR or another entity engaged by the CONTRACTOR, either as an employee, subcontractor, or contractor of lower tier, for performance of a particular construction activity, including installation, erection, application, and similar operations. Installers are required to be experienced in the operations they are engaged to perform.
 - 1. The term experienced, when used with the term Installer, means having a minimum of five previous projects similar in size and scope to this Project, being familiar with the special requirements indicated, and having complied with requirements of the authority having jurisdiction.
 - 2. Trades: Using terms such as carpentry is not intended to imply that certain construction activities must be performed by accredited or unionized individuals of a corresponding generic name, such as carpenter. It also does not imply that requirements specified apply exclusively to tradespersons of the corresponding generic name.
- J. OWNER: The term OWNER is used to mean the owner of the project.
- K. Remove: The term remove means to take away, to extract, do away with and eliminate from the Project Site. All removed materials, hardware, equipment, devices, poles and related items shall be disposed of in an accepted and legal manner.
- L. Testing Laboratories: A testing laboratory is an independent entity engaged to perform specific observations or tests, either at the Project Site or elsewhere, and to report on and, if required, to interpret results of those observations or tests.

1.12 INDUSTRY STANDARDS

- A. Applicability of Standards: Except where the Contract Documents include more stringent requirements, applicable construction industry standards have the same force and effect as if bound or copied directly into the Contract Documents to the extent referenced. Such standards are made a part of the Contract Documents by reference.
- B. Publication Dates: Comply with the standards in effect as of the date of the Contract Documents.
- C. Conflicting Requirements: Where compliance with two or more standards is specified and the standards may establish different or conflicting requirements for minimum quantities or quality levels. Refer requirements that are different but apparently equal and uncertainties to the ENGINEER for a decision before proceeding.
- D. Copies of Standards: Each entity engaged in construction of the Project is required to be familiar with industry standards applicable to that entity's construction activity. Copies of applicable standards are not bound with the Contract Documents.
 - 1. Where copies of standards are needed for performance of a required construction activity, the CONTRACTOR shall obtain copies directly from the publication source.
- E. Abbreviations and Names: Trade association names and titles of general standards are frequently abbreviated. Names and addresses can be furnished to the CONTRACTOR if requested.

1.13 WARRANTY

- A. Guarantee all work performed and materials and equipment installed to the full extent required by the Drawings and Specifications to be free from inherent defects of material and workmanship for a period of one (1) year from the date of final acceptance.
- B. Replace any material and equipment prior to the final acceptance which is corroded or otherwise damaged through the mechanical contractor's failure to properly operate and maintain the installation during construction or retesting.
- C. Keep the work in repair and replace any defective materials, equipment or workmanship upon notice from the ENGINEER or OWNER'S representative for a period of one year from date of acceptance.
- D. Consider defective all material or equipment requiring excessive service during the first year of operation.
- E. The date of acceptance of the project appears on the ENGINEER'S certificate of substantial completion.

1.14 INSURANCE

- A. The CONTRACTOR shall, during the life of the Contract, maintain in force such insurance as is required of the General Contractor in the General Conditions of the Contract; and shall furnish the General Contractor and the OWNER with certification of such insurance before beginning work on this section of the Contract.

1.15 COOPERATION BETWEEN TRADES

- A. The CONTRACTOR shall provide full information sufficiently in advance of this work so that all necessary work by other trades may be planned and installed without any delays or conflicts.
The CONTRACTOR shall furnish and locate all sleeves, supports, and anchors. Failure of the CONTRACTOR to give timely notice of and to locate openings and furnish sleeves for his work shall cause him the extra expense of cutting these openings, all at no additional expense to the OWNER. The CONTRACTOR shall locate all necessary access panels, wall and floor sleeves, and conduit penetrations through roof to complete work in advance without delay to the other trades.
- B. It is not the intention of the Drawings to show every item, piece of equipment, and detail.
Provide complete operating systems.
- C. Install work as closely as possible to layouts shown on Drawings. Modify work as necessary to meet job conditions and to clear other equipment. Consult ENGINEER before making changes which affect the function of systems or appearance.
- D. Dimensions, elevations, and locations are shown approximately. Verify all measurements in the field prior to installation.
- E. ENGINEER reserves the right to order changes in layout of such items as lighting layouts, and equipment, if such changes do not substantially affect costs and if affected items have not been fabricated or installed.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Materials and equipment shall be listed by Underwriters' Laboratories, or other OSHA accepted testing laboratory, unless it can be demonstrated that no UL standards exist for a specific item or class of equipment. Electrical equipment shall be heavy duty industrial grade or Federal Specification Grade or better. Residential or commercial grade products will not be accepted. All other materials, not specifically described but required for a complete and operable electrical installation, shall be new, first quality of their respective kinds, specification grade or better, and as selected by the CONTRACTOR subject to the approval of the ENGINEER. Rough in and make final connections of electrical to all equipment furnished under other sections.
Connections shall include necessary disconnect switches, etc. CONTRACTOR shall obtain accepted rough in drawings for equipment before starting work. Rough in work done without accepted drawings shall be relocated at CONTRACTOR'S expense

- B. All control panels, whether fabricated by CONTRACTOR or furnished as part of a manufactured equipment assembly, shall be constructed to standards of and contain only products and components that have been tested and labeled by UL, ETL, FM, or other OSHA accepted independent testing laboratory. All control panels shall be UL listed as a complete assembly or be a UL Field Evaluated Product. The CONTRACTOR shall bear all costs related to the UL field evaluation, panel modifications and follow-up evaluations. Control panels failing to meet UL listing standards shall be removed and replaced by listed panels at no cost to the OWNER.
- C. All other materials, not specifically described but required for a complete and operable electrical installation, shall be new, first quality of their respective kinds, and as selected by the CONTRACTOR subject to the acceptance by the ENGINEER. The ENGINEER reserves the right to reject any submittal which contains equipment from various manufacturers if suitable materials can be secured from fewer manufacturers and to require that source of materials be unified to the maximum extent possible.
- D. Locate all equipment which must be serviced, operated, or maintained in full accessible positions. Equipment shall include but not be limited to motors, controllers, switchgear and panels.

2.02 INTERCHANGEABILITY

- A. In all design and purchasing, interchangeability of items of equipment, subassemblies, parts, and other items is essential. For ease of maintenance and parts replacement, all similar items shall be of the same manufacturer, type, model and dimensions.
- B. The ENGINEER reserves the right to reject any submittal which contains equipment from various manufacturers if suitable materials can be secured from fewer manufacturers and to require that source of materials be unified to the maximum extent possible.

2.03 ACCESSIBILITY

- A. Verify the sufficiency and the size of spaces for the proper installation of the work. Coordinate and cooperate with all other trades whose work is within the same space. Coordinate clearance requirements among various pieces of equipment that will be installed in close proximity with one another to eliminate equipment conflicts and interference.
- B. Locate all equipment which must be serviced, operated, or maintained in full accessible positions. Equipment shall include but not be limited to motors, controllers, switchgear and panels. Coordinate and cooperate with all other trades whose work is within the same space. N.E.C. Code clearances shall be maintained at all times and shall be considered the minimum clearances allowed.

2.04 CONNECTIONS TO EQUIPMENT AND FIXTURES

- A. Rough-in and make final connections of electrical to all equipment furnished under other sections. Connections shall include necessary disconnect switches, etc. CONTRACTOR shall obtain accepted rough-in drawings for equipment before starting work. Rough-in work done without accepted drawings shall be relocated at Contractor's expense.

2.05 PAINTING AND CLEANING

- A. Painting shall be under the Section 09900 except as stated below.
- B. Metal surfaces (conduit hangers, supports, etc.) exposed to outdoors shall be given two (2) coats of rust inhibiting paint by the installing CONTRACTOR per manufacturer's instructions.
- C. Conduit, steel, bolts, etc. installed in earth or below vapor barrier shall be given two (2) coats of zinc rich compound. Material embedded in concrete need not be painted. Conduit protruding through concrete floors shall be plastic at the point of breach.

2.06 ELECTRICAL EQUIPMENT MANUFACTURERS

- A. Acceptable Manufacturers:
 1. Eaton Corporation; Cutler-Hammer Products.
 2. ABB - General Electric Co.; Electrical Distribution & Control Division.

3. Siemens Energy & Automation, Inc.
 4. Square D/Group Schneider.
- B. Substitutions: Items of same function and performance are acceptable in conformance with the General Requirements. Manufacturer's catalog numbers are used to define quality and performance and are not intended to prohibit use of comparable products by other manufacturers.

2.07 BUILDING WIRING AND IT CABLING

- A. Branch circuit wiring in conduit shall be type THHN-THWN, 600V copper, UL Listed. Minimum size: #12 AWG with ground. Wiring larger than #8 shall be stranded. All wiring shall be in conduit (EMT) or type MC as accepted by the Engineer.
- B. Communication Cables and IT Systems – The IT wiring and support systems shall be fully coordinated with the Owner and shall meet the following minimum requirements, the Owner reserves the right to change or modify the cables and components to meet their latest requirements. Refer to notes on drawings.
 1. Horizontal voice station cable shall be four-pair, 24 AWG, 100-Ohm, Enhanced Category 6E (350 MHz) UTP, with polyolefin insulation and flame retardant PVC jacket, Berk-Tek Landmark-100, or equal. Provide plenum rated sheath where cable is routed exposed through air handling plenums. ANSI/TIA/EIA-568-B.2 Category 6E.
 2. Horizontal data station cable shall be four-pair, 24 AWG, 100-Ohm, Category 6E (500 MHz) UTP, with polyolefin insulation and flame retardant PVC jacket, Berk-Tek Landmark-1000, or equal. Provide plenum rated sheath where cable is routed exposed through air handling plenums. ANSI/TIA/EIA-568-B.2 Category 6E.
 3. Provide color coding of station cable jackets so as to readily distinguish between data and voice cables, and between field cables of various other low voltage systems, such as EMCS, CCTV, clocks, etc.
 4. Pathways shall be electric metallic tubing (EMT) meeting all requirements of this Section. Minimum conduit size shall be 1 inch. All bends shall be long radius, suitable for installation of communications cables.
 5. Cable tray, D rings or J hooks and ladder rack shall be sized to meet the requirements for the cable runs and shall meet the requirements of ANSI/TIA/EIA-569. Used where open to ceiling in exposed areas of the building.
 6. J hooks shall be designed specifically to support telecommunications cabling of the type used in this project. Used only above suspended ceiling with access. Conduit above hard finished ceilings or in walls.
 7. Outlet boxes shall be minimum 4 11/16" square x 2-1/8" deep with single or two-gang plaster ring as required.
 8. Telecommunications outlet faceplates shall be as manufactured by Panduit or accepted equal, and shall be of the same material and finish as specified for electrical device coverplates. Faceplates shall contain the indicated quantity of eight-pin modular jacks. Jacks for data shall be blue in color, and rated as Category 6. Jacks for voice shall be ivory, and rated Category 6. Provide blank inserts for spare ports.
 - a. Combination voice/data locations shall have a four-position faceplate with two jacks installed. The top (or left) jack shall be "voice." The bottom (or right) position shall be "data." The two center ports shall be spare.
 - b. Voice only, or data only, locations shall have a four-position faceplate with a single eight-pin modular jack in the top (or left) position. The other three ports shall be spare.
- C. Conduit shall be EMT. Motor connections shall be made with flexible conduit and matching connectors.
- D. Conduit underground shall be schedule 40 PVC, 3/4" minimum.
- E. Splices for #10 AWG and smaller wire shall be wire nut type and solderless lugs for # 8 AWG and larger.

- F. Color-Coding for Phase and Voltage Level Identification, 600 V and Less: Use the colors listed below for ungrounded service, feeder, and branch-circuit conductors.
1. Color shall be factory applied.
 2. Colors for 208Y/120-V and 240/120 Circuits:
 - a. Phase A: Black.
 - b. Phase B: Red.
 - c. Phase C: Blue.
 - d. Neutral: White
 - e. Switch leg - Other than phase wire color
 - f. Ground - Green, if insulated
 3. Colors for 480Y/277-V Circuits:
 - a. Phase A: Brown.
 - b. Phase B: Orange.
 - c. Phase C: Yellow.
 - d. Neutral: Grey
 - e. Ground - Green, if insulated
- G. Pull and junction and boxes:
1. Pullboxes and junction boxes: Metal or nonmetallic type construction, conforming to National Electrical Code, with screw-on or hinged cover, size and locate boxes as required.
 2. Enclosure types shall be used as follows:
 - a. NEMA 1 - Interior locations, dry.
 - b. NEMA 12 - Interior locations subject to oil seepage or dust, may substituted for NEMA 1.
 - c. NEMA 3R - Exterior wet locations on outdoor structures where moisture is present, enclosures are to be constructed of stainless steel or painted aluminum.

2.08 DISCONNECT SWITCHES

- A. Provide heavy-duty type, fused or unfused as required. Fuses shall be type time delay RK-1 or equivalent, unless otherwise noted. Provide for all HVAC equipment where not furnished with equipment or by Division 23, fully coordinate between trades.

2.09 FUSIBLE AND NONFUSIBLE SWITCHES

- A. Fusible Switch, 600 A and Smaller: NEMA BS 31047, Type HD, with clips or bolt pads to accommodate specified fuses, lockable handle with capability to accept two padlocks, and interlocked with cover in closed position.
- B. Nonfusible Switch, 600 A and Smaller: NEMA BS 31047, Type HD, lockable handle with capability to accept two padlocks, and interlocked with cover in closed position.
- C. Accessories:
1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
 2. Neutral Kit: Internally mounted; insulated, capable of being grounded, and bonded; and labeled for copper and aluminum neutral conductors.
 3. Auxiliary Contact Kit: Auxiliary set of contacts arranged to open before switch blades open.

2.10 MOLDED-CASE CIRCUIT BREAKERS AND SWITCHES

- A. Molded-Case Circuit Breaker: NEMA AB 1, with interrupting capacity 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. Adjustable Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.

3. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller and let-through ratings less than NEMA FU 1, RK-5.
 4. GFCI Circuit Breakers: Single- and two-pole configurations with 5-mA trip sensitivity.
- B. Molded-Case Circuit-Breaker Features and Accessories:
1. Standard frame sizes, trip ratings, and number of poles.
 2. Lugs: Mechanical style with compression lug kits suitable for number, size, trip ratings, and conductor material.
 3. Application Listing: Type SWD for switching fluorescent lighting loads; Type HACR for heating, air-conditioning, and refrigerating equipment.

2.11 ENCLOSURES

- A. NEMA AB 1 and NEMA BS 31047 to meet environmental conditions of installed location.
1. Outdoor Locations: NEMA EN 10250, Type 3R.
 2. Chemical: NEMA EN 10250, Type 4X, stainless steel or non-metallic, compatible with chemical
 3. Other Wet or Damp Indoor Locations: NEMA EN 10250, Type 4.

2.12 GROUNDING

- A. Work included:
1. Furnishing power system grounding.
 2. Installation.
 3. Provide and install each electrical grounding system with assembly of materials required for complete installation including wires/cables, connectors, lugs, clamps, ground rods, bonding jumpers and accessories.
 4. Provide and install electrical connectors, lugs, clamps, bonding jumpers and accessories as recommended by the respective manufacturer for the particular application, unless other indicated.
- B. Grounding and bonding execution:
1. Install bonding jumper for flexible metal conduit unless fittings are accepted for grounding or otherwise comply with N.E.C.
 - a. Size jumper to match over-current device.
 - b. Green insulation.
 - c. Connect to grounding bushing at each end.
 2. Ensure that entire electrical system is electrically continuous and permanently and effectively grounded, including all electrical equipment and motors.

2.13 SUPPORTING DEVICES AND LABELS

- A. Galvanized conduit clamps. Do not use perforated pipe straps.
- B. Anchor Methods:
1. Solid masonry: accepted stainless steel expansion anchors or preset inserts. Rawl or Diamond Manufacturer or equal.
 2. Metal surfaces: galvanized machine screws, bolts, or welded studs.
 3. Concrete surfaces: Self-drilling stainless steel anchors or power-driven studs. Star, Diamond or Rawl Manufacturer or equal.
 4. Comply with NFPA 70 and 29 CFR 1910.145. Self-Adhesive Warning Labels: Factory printed, multicolor, pressure-sensitive adhesive labels, configured for display on front cover, door, or other access to equipment, unless otherwise indicated.
 5. EQUIPMENT IDENTIFICATION LABELS
 - a. Adhesive Film Label with Clear Protective Overlay: Machine printed, in black, by thermal transfer or equivalent process. Minimum letter height shall be 3/8 inch. Overlay shall provide a weatherproof and ultraviolet-resistant seal for label.
 - b. Self-Adhesive, Engraved, Laminated Acrylic or Melamine Label: Adhesive backed, with white letters on a dark-gray background. Minimum letter height shall be 3/8 inch.

6. Auxiliary Electrical Systems including equipment, conductors and cable identification: Use marker tape to identify field-installed alarm, control, signal, communications, voice, and data wiring connections.
 - a. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, and cable pull points. Identify by system and circuit designation.
 - b. Use system of designations that is uniform and consistent with system used by manufacturer for factory-installed connections.
 - c. Warning Labels for Indoor Cabinets, Boxes, and Enclosures for Power and Lighting: Comply with 29 CFR 1910.145 and apply self-adhesive warning labels, baked-enamel warning signs, or metal-backed, butyrate warning signs. Identify system voltage with black letters on an orange background. Apply to exterior of door, cover, or other access.
 - d. Equipment with Multiple Power or Control Sources: Apply to door or cover of equipment including, but not limited to, the following: Equipment Requiring Workspace Clearance According to NFPA 70: Unless otherwise indicated, apply to door or cover of equipment but not on flush panelboards and similar equipment in finished spaces.
7. Equipment Identification Labels: On each unit of equipment, install unique designation label that is consistent with wiring diagrams, schedules, and Operation and Maintenance Manual. Apply labels to disconnect switches and protection equipment, central or master units, control panels, control stations, terminal cabinets, and racks of each system.
8. Systems include power, lighting, control, communication, signal, monitoring, and alarm systems unless equipment is provided with its own identification. Outdoor Equipment: Engraved, laminated acrylic or melamine label, drilled for screw attachment. The following devices shall be labeled: Panelboards, electrical cabinets, enclosures, transformers, control centers, disconnect switches, circuit breakers, power transfer equipment, and contactors.

2.14 DEVICES AND OUTLET BOXES

- A. Outlet Box Construction:
 1. Interior locations: Steel 4"square minimum conforming to UL requirements.
 2. Exterior locations: Cast metal, deep type.
- B. Size boxes per NEC, minimum 1-1/2 inches deep. Use gang boxes for multiple outlets.
- C. Cover plates:
 1. Provide openings as required.
- D. Devices – Note: Provide Specification Grade devices 120V, 20A, UL Listed. Color Ivory with matching cover plates.
 1. Receptacles, receptacles with integral GFCI, and associated device plates.
 2. Receptacles with integral surge suppression units.
 3. Snap switches.
 4. Wall-switch occupancy sensors.
 5. Communications outlets.
 6. Ceiling mounted occupancy sensors.
- E. Source Limitations: Obtain each type of wiring device and associated wall plate through one source from a single manufacturer. Insofar as they are available, obtain all wiring devices and associated wall plates from a single manufacturer and one source.
- F. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NEC, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- G. Manufacturers' Names: Shortened versions (shown in parentheses):
 1. Cooper Wiring Devices; a division of Cooper Industries, Inc. (Cooper).
 2. Hubbell Incorporated; Wiring Device-Kellems (Hubbell).

3. Leviton Mfg. Company Inc. (Leviton).
 4. Pass & Seymour/Legrand; Wiring Devices & Accessories (Pass & Seymour).
- H. Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 configuration 5-20R, and UL 498.
1. Cooper; 5351 (single), 5352 (duplex).
 2. Hubbell; HBL5351 (single), CR5352 (duplex).
 3. Leviton; 5891 (single), 5352 (duplex).
 4. Pass & Seymour; 5381 (single), 5352 (duplex).
- I. GFCI Receptacles - General Description: Straight blade, feed-through type. Comply with NEMA WD 1, NEMA WD 6, UL 498, and UL 943, Class A, and include indicator light that is lighted when device is tripped. Hospital Grade as noted on Drawings.
- J. Duplex GFCI Convenience Receptacles, 125 V, 20 A, Hospital Grade as noted on Drawings:
1. Cooper; GF20.
 2. Pass & Seymour; 2084.
- K. Switches, 120/277 V, 20 A:
1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Cooper; 2221 (single pole), 2222 (two pole), 2223 (three way), 2224 (four way).
 - b. Hubbell; CS1221 (single pole), CS1222 (two pole), CS1223 (three way), CS1224 (four way).
 - c. Leviton; 1221-2 (single pole), 1222-2 (two pole), 1223-2 (three way), 1224-2 (four way).
 - d. Pass & Seymour; 20AC1 (single pole), 20AC2 (two pole), 20AC3 (three way), 20AC4 (four way).
- L. Wall Plates - Single and combination types to match corresponding wiring devices.
1. Plate-Securing Screws: Metal with head color to match plate finish.
 2. Material for Finished Spaces: Smooth, high-impact nylon or thermoplastic.
 3. Material for Unfinished Spaces: Smooth, high-impact nylon or thermoplastic.
 4. Material for Damp Locations: Thermoplastic with spring-loaded lift covers, and listed and labeled for use in "wet locations."
- M. Wet-Location, Weatherproof Cover Plates: NEMA EN 10250, complying with type 3R weather-resistant thermoplastic with lockable cover.
- N. Multi-Outlet Assemblies: Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Hubbell Incorporated; Wiring Device-Kellems.
 - b. Wiremold Company (The).
 2. Components of Assemblies: Products from a single manufacturer designed for use as a complete, matching assembly of raceways and receptacles.
 3. Raceway Material: Metal, with manufacturer's standard finish.
 4. Wire: No. 12 AWG.
- O. Device Wiring
1. Comply with NECA 1, including the mounting heights listed in that standard, unless otherwise noted.
 2. Coordination with Other Trades: Take steps to insure that devices and their boxes are protected. Do not place wall finish materials over device boxes and do not cut holes for boxes with routers that are guided by riding against outside of the boxes.
 3. Keep outlet boxes free of plaster, drywall joint compound, mortar, cement, concrete, dust, paint, and other material that may contaminate the raceway system, conductors, and cables.
 4. Install device boxes in brick or block walls so that the cover plate does not cross a joint unless the joint is troweled flush with the face of the wall.

5. Install wiring devices after all wall preparation, including painting, is complete.
6. Conductors And Device installation:
 - a. Do not strip insulation from conductors until just before they are spliced or terminated on devices.
 - b. Strip insulation evenly around the conductor using tools designed for the purpose. Avoid scoring or nicking of solid wire or cutting strands from stranded wire.
 - c. The length of free conductors at outlets for devices shall meet provisions of NEC, Article 300, without pigtails.
7. Replace all devices that have been in temporary use during construction or that show signs that they were installed before building finishing operations were complete.
 - a. Keep each wiring device in its package or otherwise protected until it is time to connect conductors.
 - b. Do not remove surface protection, such as plastic film and smudge covers, until the last possible moment.
 - c. Connect devices to branch circuits using pigtails that are not less than 6 inches (152 mm) in length.
 - d. When there is a choice, use side wiring with binding-head screw terminals. Wrap solid conductor tightly clockwise, 2/3 to 3/4 of the way around terminal screw.
 - e. Use a torque screwdriver when a torque is recommended or required by the manufacturer.
 - f. When conductors larger than No. 12 AWG are installed on 15- or 20-A circuits, splice No. 12 AWG pigtails for device connections.

2.15 TRANSFORMERS

- A. Comply with NEMA ST 20, and list and label as complying with UL 1561.
- B. Cores: One leg per phase.
- C. Enclosure: Totally enclosed, nonventilated, NEMA EN 10250, Type 2.
 1. Core and coil shall be encapsulated within resin compound, sealing out moisture and air.
 2. Core and coil shall be encapsulated within resin compound, sealing out moisture and air.
- D. Transformer Enclosure Finish: Comply with NEMA EN 10250.
 1. Finish Color: Gray.
- E. Taps for Transformers Smaller Than 3 kVA: One 5 percent tap above normal full capacity.
- F. Taps for Transformers 7.5 to 24 kVA: One 5 percent tap above and one 5 percent tap below normal full capacity.
- G. Taps for Transformers 25 kVA and Larger: Two 2.5 percent taps above and two 2.5 percent taps below normal full capacity.
- H. Insulation Class: 220 deg C, UL-component-recognized insulation system with a maximum of 150 deg C rise above 40 deg C ambient temperature.
- I. Energy Efficiency for Transformers Rated 15 kVA and Larger:
 1. Complying with NEMA TP 1, Class 1 efficiency levels.
 2. Tested according to NEMA TP 2.
- J. Wall Brackets: Manufacturer's standard brackets.

2.16 ACROSS-THE-LINE ENCLOSED CONTROLLERS

- A. Manual Controller: NEMA ICS 2, general purpose, Class A, with "quick-make, quick-break" toggle or pushbutton action, and marked to show whether unit is "OFF," "ON," or "TRIPPED."
 1. Overload Relay: Ambient-compensated type with inverse-time-current characteristics and NEMA ICS 2, Class 10 tripping characteristics. Relays shall have heaters and sensors in each phase, matched to nameplate, full-load current of specific motor to which they connect and shall have appropriate adjustment for duty cycle.

- B. Magnetic Controller: NEMA ICS 2, Class A, full voltage, nonreversing, across the line, unless otherwise indicated.
 - 1. Control Circuit: 120 V; obtained from integral control power transformer with a control power transformer of sufficient capacity to operate connected pilot, indicating and control devices, plus 100 percent spare capacity.
 - 2. Overload Relay: Ambient-compensated type with inverse-time-current characteristic and NEMA ICS 2, Class 20 tripping characteristic. Provide with heaters or sensors in each phase matched to nameplate full-load current of specific motor to which they connect and with appropriate adjustment for duty cycle.
 - 3. Adjustable Overload Relay: Dip switch selectable for motor running overload protection with NEMA ICS 2, Class 20 tripping characteristic, and selected to protect motor against voltage and current unbalance and single phasing. Provide relay with Class II ground-fault protection, with start and run delays to prevent nuisance trip on starting.
- C. Combination Magnetic Controller: Factory-assembled combination controller and disconnect switch.
 - 1. Fusible Disconnecting Means: NEMA BS 31047, heavy-duty, fusible switch with rejection-type fuse clips rated for fuses. Select and size fuses to provide Type 2 protection according to IEC 947-4-1, as certified by an NRTL.
 - 2. Nonfusible Disconnecting Means: NEMA BS 31047, heavy-duty, nonfusible switch.
 - 3. Circuit-Breaker Disconnecting Means: NEMA AB 1, motor-circuit protector with field-adjustable, short-circuit trip coordinated with motor locked-rotor amperes.

2.17 CIRCUIT BREAKER PANELBOARD

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following Panelboards, Overcurrent Protective Devices, Controllers, Contactors, and Accessories:
 - 1. Schneider Electric; Square D Products: www.schneider-electric.us/#sle.
 - 2. Eaton Corporation: www.eaton.com/#sle.
 - 3. ABB - General Electric Co.; Electrical Distribution & Protection Div.
 - 4. Siemens Industry, Inc: www.usa.siemens.com/#sle.
- B. Fabricate and test panelboards according to IEEE 344 to withstand seismic forces defined in Section 26 0529 - Hangers and Supports for Electrical Systems.
- C. Enclosures: Surface-mounted cabinets. NEMA PB 1, Type 1.
- D. Front: Secured to box with concealed trim clamps. For surface-mounted fronts, match box dimensions; for flush-mounted fronts, overlap box.
- E. Hinged Front Cover: Entire front trim hinged to box and with standard door within hinged trim cover.
- F. Gutter Extension and Barrier: Same gage and finish as panelboard enclosure; integral with enclosure body. Arrange to isolate individual panel sections.
- G. Column-Type Panelboards: Narrow gutter extension, with cover, to overhead junction box equipped with ground and neutral terminal buses.
- H. Finish: Manufacturer's standard enamel finish over corrosion-resistant treatment or primer coat.
- I. Directory Card: With transparent protective cover, mounted in metal frame, inside panelboard door.
- J. Phase and Ground Buses:
 - 1. Material: Hard-drawn copper, 98 percent conductivity.
- K. Equipment Ground Bus: Adequate for feeder and branch-circuit equipment ground conductors; bonded to box.
 - 1. Conductor Connectors: Suitable for use with conductor material.
- L. Main and Neutral Lugs: Mechanical type.

- M. Ground Lugs and Bus Configured Terminators: Compression type.
- N. PANELBOARD SHORT-CIRCUIT RATING
 - 1. Fully rated to interrupt symmetrical short-circuit current available at terminals.
- O. For Circuit-Breaker Frame Sizes 125 A and Smaller: Bolt-on circuit breakers.
- P. For Circuit-Breaker Frame Sizes Larger Than 125 A: Bolt-on circuit breakers.
 - 1. Branch Overcurrent Protective Devices: Bolt-on circuit breakers, replaceable without disturbing adjacent units.
 - 2. Doors: Door in door construction with concealed hinges; secured with flush latch with tumbler lock; keyed alike.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install all equipment and fixtures in complete accordance with the manufacturer's recommendations and all pertinent codes and regulations.
- B. Thoroughly observe all items of equipment and any items dented, scratched or otherwise damaged in any manner shall be replaced or repaired and painted to match original finish.
 - 1. All items so repaired and refinished shall be brought to the attention of the ARCHITECT for observation and approval.
- C. Upon completion of all installation, lamping, and testing, thoroughly observe all exposed portions of the electrical installation and completely remove all exposed labels, soil, markings and foreign material.

3.02 CUTTING AND PATCHING

- A. All cutting and patching shall be as described under other Sections.

3.03 FLOOR AND WALL PENETRATIONS

- A. Provide, locate and set all sleeves and inserts as required for this work. Prepare dimensioned floor and wall penetration drawings, showing the size and location of each penetration on every floor and in every wall which is to accommodate this work. The penetration drawings shall include, but not be limited to hangers, inserts, conduits, raceways, and curbs.
 - 1. Drawings shall be submitted to the ARCHITECT in advance of the work to be done in order that adjustments may be made to the reinforcing steel, structural framing and other related work without interruption to the construction schedule. All sleeves, collars, hangers, inserts, etc. shall be installed in accordance with the penetration drawings prior to constructing floors and walls. Each CONTRACTOR shall be responsible for any drilling and as accepted by the ARCHITECT.
- B. Should the penetration drawings be incomplete the CONTRACTOR shall bear the full cost of all work for the cutting and patching required making the correction.
- C. Where conduit motion due to expansion and contraction will occur, make sleeves of sufficient diameter to permit free movement. Check floor and wall construction finish to determine proper length of sleeves for various locations, make actual length to suit the following:
 - 1. Terminate sleeves flush with walls, partitions, and ceiling.
 - 2. In areas where conduit is concealed, as in chases, terminate sleeves flush with floor.
 - 3. In all areas where conduit is exposed, extend sleeves 1/4" above finished floor, except in rooms having floor drains, where sleeves shall be extended 3/4" above floor.
- D. Sleeves shall be constructed of 22-gauge galvanized sheet steel with lock seam joints for all sleeves set in concrete floor slabs terminating flush with the floor. All other sleeves shall be constructed of galvanized steel pipe.
- E. Fasten sleeves securely in floors, walls, etc. so that they will not become displaced when concrete is poured or when other construction is built around them. Take precautions to prevent concrete, plaster, or other materials being forced into the space between pipe and sleeve during construction.

- F. Where conduits pass through floors or rated walls, the openings around the conduits shall be sealed with 3M, Hilti or accepted fire sealing compound provided by an accepted manufacturer. Conduit floor penetrations within rated chases shall be sealed with smoke barrier sealants. The 3M, Hilti or accepted manufacturer's type sealant used shall be accepted by the local authorities having jurisdiction and carry U.L. listing for rating of assembly. All products shall be listed for a two hour rating unless noted otherwise.
- G. All conduits and related branch circuits in any exterior locations in the facility shall be sealed watertight to prevent water and condensation from entering the building or fixtures, boxes, receptacles and related devices.

3.04 ELECTRICAL CONNECTIONS TO EQUIPMENT AND SYSTEMS

- A. Equipment wiring shall be as follows:
 - 1. All wiring shall be provided under Division 26 except the following which shall be provided under Division 23 (assigned to Division 26 per the drawings): All associated control wiring for equipment described under Division 23 and other control wiring required to be provided by Division 23.
 - 2. All starters for HVAC systems not factory mounted on equipment shall be furnished under Division 26 and installed under Division 26. Heating elements for starters shall be provided under Division 26 and installed under Division 26.
 - 3. All control items connected shall be marked plainly by machine-made nameplate on the equipment that is controlled, to the acceptance of the OWNER.
 - 4. The horsepower rating of all starters shall be checked against actual motor to be controlled, before installation, and correct size overload elements shall be provided in all starters based on nameplate and manufacturer's recommendation.
 - 5. After all circuits are energized and completed, the power wiring responsibility shall be under the Division 26 and control wiring responsibility under the Division 23 (unless assigned to Division 26 per the drawings). Motors and controllers shall be provided for voltage and current characteristics as indicated in Division providing the equipment. In the event that equipment provided is of different electrical characteristics than the ones specified, any increase in electrical feeders, conduits, circuit breakers, etc., including increase of labor cost shall be the responsibility of the Division which provided the equipment of different characteristics than those specified.
 - 6. All power wiring complete from power source to motor or equipment junction box, including power wiring through starters shall be furnished and installed under Division 26.
 - 7. General Clearance Requirements: Provide clearance spaces between and around process, mechanical and electrical equipment for operation, maintenance and replacement of equipment. Minimum clearances for each item or piece of equipment shall be as stated in the manufacturer's printed recommendations or as shown on the manufacturer's printed drawings. Coordinate clearance requirements among various pieces of equipment that will be installed in close proximity with one another to eliminate equipment conflicts and interference. Prepare and submit shop drawings if requested by the ARCHITECT showing proposed equipment layouts and clearances. N.E.C. Code clearances shall be maintained at all times and shall be considered the minimum clearances allowed.

3.05 SALVAGE, REMOVAL AND DEMOLITION OF EXISTING EQUIPMENT

- A. Assign the work of moving, removal, cutting and patching to CONTRACTOR'S qualified personnel. Perform the work in a manner to cause least damage to each type of work.
- B. Replace or repair any damage done by reason of required work. The CONTRACTOR will maintain a list of items that have been salvaged for reuse; this may include power and lighting panels or equipment as noted on the Contract Drawings scheduled for removal and an inventory of the conditions of said electrical items. These items will be turned over to the OWNER if so requested by the OWNER. This list shall be the basis of inventory and condition, so that in the event items and equipment are damaged during removal a record of the prior condition is available and the proper restitution can be made.

- C. Insure that all electrical equipment, conduit and wiring that would be interrupted during the work are turned off, and locked out, or disconnected before starting work. Coordinate any interruptions with CONTRACTOR AND OWNER.
- D. Relocate, support and protect existing materials and equipment indicated to remain so as to avoid damage. Seal conduit systems and terminate properly.
- E. Cap weather tight and watertight as required all conduits that extend to the building exterior. Identify branch circuits and indicate locations of utilities, branch circuits and feeders on Project Record Documents.
- F. Schedule with CONTRACTOR and OWNER any interruption of services to occupied portions of the building, electrical systems and schedule outages to minimize disruption to OWNER'S activities and requirements.
- G. Equipment to be salvaged for spare parts for the OWNER is indicated on the Drawings as being removed by Division 26 (i.e., lighting fixtures in the stairwells and parking deck top level poles lighting fixtures). These items shall be dismantled, handled with care, wrapped, boxed and tagged and stored carefully to minimize any damage and permit future use if so instructed.

3.06 DEBRIS

- A. All debris shall be removed as it accumulates and shall not be stored or permitted to accumulate on-site. Remove all debris at the end of each working day.

3.07 ENERGIZING ELECTRICAL SYSTEM

- A. Prior to energizing main electrical system perform the following:
 - 1. Verify supply authority voltage and phase rotation. Ensure all independent testing as specified has been completed and deficiencies have been corrected.
 - a. Megger all feeders and record results on accepted test report forms.
 - b. Test conductors at switchboards, distribution centres and panelboards for insulation resistance to ground (megger test).
 - c. Test service grounding conductors for ground resistance.
 - d. Test all wiring devices for correct operation and circuitry.
 - e. Load Balance Testing Perform load tests with as many loads on as possible.

END OF SECTION

SECTION 26 3213 ENGINE GENERATORS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Packaged engine generator system and associated components and accessories:
 - 1. Engine and engine accessory equipment.
 - 2. Alternator (generator).
 - 3. Generator set control system.
 - 4. Generator set enclosure.

1.02 RELATED REQUIREMENTS

- A. Section 03 3000 - Cast-in-Place Concrete: Concrete equipment pads.
- B. Section 23 1126 - Facility Liquefied-Petroleum Gas Piping.
- C. Section 23 5100 - Breechings, Chimneys, and Stacks: Engine exhaust piping.
 - 1. Includes installation of exhaust silencer specified in this section.
- D. Section 26 0526 - Grounding and Bonding for Electrical Systems.
- E. Section 26 0529 - Hangers and Supports for Electrical Systems.
- F. Section 26 0553 - Identification for Electrical Systems: Identification products and requirements.
- G. Section 26 0583 - Wiring Connections: Electrical characteristics and wiring connections.
- H. Section 26 3600 - Transfer Switches.

1.03 REFERENCE STANDARDS

- A. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2023.
- B. NECA/EGSA 404 - Standard for Installing Generator Sets; 2014.
- C. NEMA MG 00001 - Motors and Generators; 2024.
- D. NFPA 37 - Standard for the Installation and Use of Stationary Combustion Engines and Gas Turbines; 2024, with Amendment.
- E. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- F. NFPA 110 - Standard for Emergency and Standby Power Systems; 2025.
- G. UL 1236 - Battery Chargers for Charging Engine-Starter Batteries; Current Edition, Including All Revisions.
- H. UL 2200 - Stationary Engine Generator Assemblies; Current Edition, Including All Revisions.

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate compatibility of generator sets to be installed with work provided under other sections or by others.
 - a. Transfer Switches: See Section 26 3600.
 - 2. Coordinate the work with other trades to avoid placement of ductwork, piping, equipment or other potential obstructions within the spaces dedicated for engine generator system.
 - 3. Coordinate arrangement of equipment with the dimensions and clearance requirements of the actual equipment to be installed.
 - 4. Coordinate the work to provide electrical circuits suitable for the power requirements of the actual auxiliary equipment and accessories to be installed.
 - 5. Notify Engineer of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

1.05 SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide manufacturer's standard catalog pages and data sheets for each product, including ratings, configurations, dimensions, finishes, weights, service condition requirements, and installed features. Include alternator starting capabilities, engine fuel consumption rates, and cooling, combustion air, and exhaust requirements.
 - 1. Include characteristic trip curves for overcurrent protective devices upon request.
 - 2. Include alternator thermal damage curve upon request.
- C. Shop Drawings: Include dimensioned plan views and sections indicating locations of system components, required clearances, and field connection locations. Include system interconnection schematic diagrams showing all factory and field connections.
- D. Specimen Warranty: Submit sample of manufacturer's warranty.
- E. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, installation, and operation of product.
- F. Manufacturer's factory emissions certification.
- G. Manufacturer's certification that products meet or exceed specified requirements.
- H. Source quality control test reports.
- I. Provide NFPA 110 required documentation from manufacturer where requested by authorities having jurisdiction, including but not limited to:
 - 1. Certified prototype tests.
 - 2. Torsional vibration compatibility certification.
 - 3. NFPA 110 compliance certification.
 - 4. Certified rated load test at rated power factor.
- J. Manufacturer's detailed field testing procedures.
- K. Field quality control test reports.
- L. Operation and Maintenance Data: Include detailed information on system operation, equipment programming and setup, replacement parts, and recommended maintenance procedures and intervals.
 - 1. Include contact information for entity that will be providing contract maintenance and trouble call-back service.
- M. Project Record Documents: Record actual locations of system components, installed circuiting arrangements and routing, and final equipment settings.
- N. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 - 1. See Section 01 6000 - Product Requirements, for additional provisions.
 - 2. Extra Fuses: One of each type and size.
 - 3. Extra Filter Elements: One of each type, including fuel, oil and air.

1.06 QUALITY ASSURANCE

- A. Comply with the following:
 - 1. NFPA 70 (National Electrical Code).
 - 2. NFPA 110 (Standard for Emergency and Standby Power Systems); meet requirements for Level 1 system.
 - 3. NFPA 37 (Standard for the Installation and Use of Stationary Combustion Engines and Gas Turbines).
- B. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.
 - 1. Authorized service facilities located within 200 miles (320 km) of project site.

- C. Installer Qualifications: Company specializing in performing the work of this section with minimum three years documented experience with engine generator systems of similar size, type, and complexity; manufacturer's authorized installer.
- D. Maintenance Contractor Qualifications: Same entity as installer or different entity with specified qualifications.
- E. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Receive, inspect, handle, and store generator sets in accordance with manufacturer's instructions and NECA/EGSA 404.
- B. Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.
- C. Handle carefully in accordance with manufacturer's instructions to avoid damage to generator set components, enclosure, and finish.

1.08 FIELD CONDITIONS

- A. Maintain field conditions within manufacturer's required service conditions during and after installation.

1.09 WARRANTY

- A. See Section 01 7800 - Closeout Submittals, for additional warranty requirements.
- B. Provide minimum one year manufacturer warranty covering repair or replacement due to defective materials or workmanship.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Packaged Engine Generator Set:
 - 1. Caterpillar Inc; _____: www.cat.com/#sle.
 - 2. Cummins Power Generation Inc; _____: www.cumminspower.com/#sle.
 - 3. Generac Power Systems; \: www.generac.com/industrial/#sle.Generac Power Systems; \: www.generac.com/industrial/#sle.Generac Power Systems; \: www.generac.com/industrial/#sle.
- B. Substitutions: See Section 01 6000 - Product Requirements.
- C. Source Limitations: Furnish engine generator sets and associated components and accessories produced by a single manufacturer and obtained from a single supplier.

2.02 PACKAGED ENGINE GENERATOR SYSTEM

- A. Provide new engine generator system consisting of all required equipment, sensors, conduit, boxes, wiring, piping, supports, accessories, system programming, etc. as necessary for a complete operating system that provides the functional intent indicated.
- B. Provide products listed, classified, and labeled as suitable for the purpose intended.
- C. System Description:
 - 1. Application: Emergency/standby.
 - 2. Configuration: Single packaged engine generator set operated independently (not in parallel).
- D. Packaged Engine Generator Set:
 - 1. Type: Gaseous (spark ignition).
 - 2. Power Rating: As indicated on drawings, standby.
 - 3. Voltage: As indicated on drawings.
 - 4. Main Line Circuit Breaker:

- a. Type: Thermal magnetic.
 - b. Trip Rating: Select according to generator set rating.
- E. Generator Set General Requirements:
 - 1. Prototype tested in accordance with NFPA 110 for Level 1 systems.
 - 2. Factory-assembled, with components mounted on suitable base.
 - 3. List and label engine generator assembly as complying with UL 2200.
 - 4. Power Factor: Unless otherwise indicated, specified power ratings are at 0.8 power factor for three phase voltages and 1.0 power factor for single phase voltages.
 - 5. Provide suitable guards to protect personnel from accidental contact with rotating parts, hot piping, and other potential sources of injury.
 - 6. Main Line Circuit Breakers: Provide factory-installed line side connections with suitable lugs for load side connections.
- F. Service Conditions: Provide engine generator system and associated components suitable for operation under the service conditions at the installed location.
- G. Starting and Load Acceptance Requirements:
 - 1. Cranking Method: Cycle cranking complying with NFPA 110 (15 second crank period, followed by 15 second rest period, with cranking limiter time-out after 3 cycles), unless otherwise required.
 - 2. Cranking Limiter Time-Out: If generator set fails to start after specified cranking period, indicate overcrank alarm condition and lock-out generator set from further cranking until manually reset.
 - 3. Start Time: Capable of starting and achieving conditions necessary for load acceptance within 10 seconds (NFPA 110, Type 10).
 - 4. Maximum Load Step: Supports 100 percent of rated load in one step.
- H. Exhaust Emissions Requirements:
 - 1. Comply with federal (EPA), state, and local regulations applicable at the time of commissioning; include factory emissions certification with submittals.
 - 2. Do not make modifications affecting generator set factory emissions certification without approval of manufacturer and Engineer. Where such modifications are made, provide field emissions testing as necessary for certification.
- I. Sound Level Requirements:
 - 1. Do not exceed 70 dBA when measured at 23 feet (7 m) from generator set in free field (no sound barriers) while operating at full load.
 - 2. Comply with applicable noise level regulations.
- J. Interface with building automation system as specified in Section _____.

2.03 ENGINE AND ENGINE ACCESSORY EQUIPMENT

- A. Provide engine with adequate horsepower to achieve specified power output at rated speed, accounting for alternator efficiency and parasitic loads.
- B. Engine Fuel System - Gaseous (Spark Ignition):
 - 1. Fuel Source: Propane (LP), vapor withdrawal.
 - 2. Engine Fuel Connections: Provide suitable, approved flexible fuel lines for coupling engine to fuel source.
 - 3. Provide components/features indicated and as necessary for operation and/or required by applicable codes, including but not limited to:
 - a. Carburetor.
 - b. Gas pressure regulators.
 - c. Fuel shutoff control valves.
 - d. Low gas pressure switches.
- C. Engine Starting System:
 - 1. System Type: Electric, with DC solenoid-activated starting motor(s).

2. Battery(s):
 - a. Battery Type: Lead-acid.
 - b. Battery Capacity: Size according to manufacturer's recommendations for achieving starting and load acceptance requirements under worst case ambient temperature; capable of providing cranking through two complete periods of cranking limiter time-outs without recharging.
 - c. Provide battery rack, cables, and connectors suitable for the supplied battery(s); size battery cables according to manufacturer's recommendations for cable length to be installed.
3. Battery-Charging Alternator: Engine-driven, with integral solid-state voltage regulation.
4. Battery Charger:
 - a. Provide dual rate battery charger with automatic float and equalize charging modes and minimum rating of 10 amps; suitable for maintaining the supplied battery(s) at full charge without manual intervention.
 - b. Capable of returning supplied battery(s) from fully discharged to fully charged condition within 24 hours, as required by NFPA 110 for Level 1 applications while carrying normal loads.
 - c. Listed as complying with UL 1236.
 - d. Furnished with integral overcurrent protection; current limited to protect charger during engine cranking; reverse polarity protection.
 - e. Provide integral DC output ammeter and voltmeter with five percent accuracy.
 - f. Provide alarm output contacts as necessary for alarm indications.
- D. Engine Speed Control System (Governor):
 1. Single Engine Generator Sets (Not Operated in Parallel): Provide electronic isochronous governor for controlling engine speed/alternator frequency.
 2. Frequency Regulation, Electronic Isochronous Governors: No change in frequency from no load to full load; plus/minus 0.25 percent at steady state.
- E. Engine Lubrication System:
 1. System Type: Full pressure, with engine-driven, positive displacement lubrication oil pump, replaceable full-flow oil filter(s), and dip-stick for oil level indication. Provide oil cooler where recommended by manufacturer.
- F. Engine Cooling System:
 1. System Type: Closed-loop, liquid-cooled, with unit-mounted radiator/fan and engine-driven coolant pump; suitable for providing adequate cooling while operating at full load under worst case ambient temperature.
 2. Fan Guard: Provide suitable guard to protect personnel from accidental contact with fan.
 3. Coolant Heater: Provide thermostatically controlled coolant heater to improve starting under cold ambient conditions; size according to manufacturer's recommendations for achieving starting and load acceptance requirements under worst case ambient temperature.
- G. Engine Air Intake and Exhaust System:
 1. Air Intake Filtration: Provide engine-mounted, replaceable, dry element filter.
 2. Engine Exhaust Connection: Provide suitable, approved flexible connector for coupling engine to exhaust system.
 3. Exhaust Silencer: Provide critical grade or better exhaust silencer with sound attenuation not less than basis of design; select according to manufacturer's recommendations to meet sound performance requirements, where specified.

2.04 ALTERNATOR (GENERATOR)

- A. Alternator: 4-pole, 1800 rpm (60 Hz output) revolving field, synchronous generator complying with NEMA MG 00001; connected to engine with flexible coupling; voltage output configuration as indicated, with reconnectable leads for 3 phase alternators.
- B. Exciter:

1. Exciter Type: Brushless; provide permanent magnet generator (PMG) excitation system; self-excited (shunt) systems are not permitted.
 2. PMG Excitation Short-Circuit Current Support: Capable of sustaining 300 percent of rated output current for 10 seconds.
 3. Voltage Regulation (with PMG excitation): Plus/minus 0.5 percent for any constant load from no load to full load.
- C. Temperature Rise: Comply with UL 2200.
- D. Insulation System: NEMA MG 00001, Class H; suitable for alternator temperature rise.
- E. Enclosure: NEMA MG 00001, drip-proof.
- F. Total Harmonic Distortion: Not greater than five percent.

2.05 GENERATOR SET CONTROL SYSTEM

- A. Provide microprocessor-based control system for automatic control, monitoring, and protection of generator set. Include sensors, wiring, and connections necessary for functions/indications specified.
- B. Control Panel:
1. Control Panel Mounting: Unit-mounted unless otherwise indicated; vibration isolated.
 2. Generator Set Control Functions:
 - a. Automatic Mode: Initiates generator set start/shutdown upon receiving corresponding signal from remote device (e.g. automatic transfer switch).
 - b. Manual Mode: Initiates generator set start/shutdown upon direction from operator.
 - c. Reset Mode: Clears all faults, allowing generator set restart after a shutdown.
 - d. Emergency Stop: Immediately shuts down generator set (without time delay) and prevents automatic restarting until manually reset.
 - e. Cycle Cranking: Programmable crank time, rest time, and number of cycles.
 - f. Time Delay: Programmable for shutdown (engine cooldown) and start (engine warmup).
 - g. Voltage Adjustment: Adjustable through range of plus/minus 5 percent.
 3. Generator Set Status Indications:
 - a. Voltage (Volts AC): Line-to-line, line-to-neutral for each phase.
 - b. Current (Amps): For each phase.
 - c. Frequency (Hz).
 - d. Real power (W/kW).
 - e. Reactive power (VAR/kVAR).
 - f. Apparent power (VA/kVA).
 - g. Power factor.
 - h. Duty Level: Actual load as percentage of rated power.
 - i. Engine speed (RPM).
 - j. Battery voltage (Volts DC).
 - k. Engine oil pressure.
 - l. Engine coolant temperature.
 - m. Engine run time.
 - n. Generator powering load (position signal from transfer switch).
 4. Generator Set Protection and Warning/Shutdown Indications:
 - a. Comply with NFPA 110; configurable for NFPA 110 Level 1 or Level 2, or NFPA 99 systems including but not limited to the following protections/indications:
 - 1) Overcrank (shutdown).
 - 2) Low coolant temperature (warning).
 - 3) High coolant temperature (warning).
 - 4) High coolant temperature (shutdown).
 - 5) Low oil pressure (shutdown).
 - 6) Overspeed (shutdown).

- 7) Low fuel level (warning).
- 8) Low coolant level (warning/shutdown).
- 9) Generator control not in automatic mode (warning).
- 10) High battery voltage (warning).
- 11) Low cranking voltage (warning).
- 12) Low battery voltage (warning).
- 13) Battery charger failure (warning).
- b. In addition to NFPA 110 requirements, provide the following protections/indications:
 - 1) High AC voltage (shutdown).
 - 2) Low AC voltage (shutdown).
 - 3) High frequency (shutdown).
 - 4) Low frequency (shutdown).
 - 5) Overcurrent (shutdown).
- c. Provide contacts for local and remote common alarm.
- d. Provide lamp test function that illuminates all indicator lamps.
- 5. Other Control Panel Features:
 - a. Event log.
- C. Remote Annunciator:
 - 1. Remote Annunciator Mounting: Wall-mounted; Provide flush-mounted annunciator for finished areas and surface-mounted annunciator for non-finished areas unless otherwise indicated.
 - 2. Generator Set Status Indications:
 - a. Generator powering load (via position signal from transfer switch).
 - b. Communication functional.
 - 3. Generator Set Warning/Shutdown Indications:
 - a. Comply with NFPA 110; configurable for NFPA 110 Level 1 or Level 2, or NFPA 99 systems including but not limited to the following indications:
 - 1) Overcrank (shutdown).
 - 2) Low coolant temperature (warning).
 - 3) High coolant temperature (warning).
 - 4) High coolant temperature (shutdown).
 - 5) Low oil pressure (shutdown).
 - 6) Overspeed (shutdown).
 - 7) Low fuel level (warning).
 - 8) Low coolant level (warning/shutdown).
 - 9) Generator control not in automatic mode (warning).
 - 10) High battery voltage (warning).
 - 11) Low cranking voltage (warning).
 - 12) Low battery voltage (warning).
 - 13) Battery charger failure (warning).
 - b. Provide audible alarm with silence function.
 - c. Provide lamp test function that illuminates all indicator lamps.
- D. Remote Emergency Stop: Provide approved red, mushroom style remote emergency stop button where indicated or required by authorities having jurisdiction.

2.06 GENERATOR SET ENCLOSURE

- A. Enclosure Type: Sound attenuating, weather protective.
- B. Enclosure Material: Steel or aluminum.
- C. Hardware Material: Stainless steel.
- D. Color: Custom color to be selected by Architect.
- E. Access Doors: Lockable, with all locks keyed alike.

- F. Openings: Designed to prevent bird/rodent entry.
- G. External Drains: Extend oil and coolant drain lines to exterior of enclosure for maintenance service.
- H. Sound Attenuating Enclosures: Line enclosure with non-hygroscopic, self-extinguishing sound-attenuating material.
- I. Exhaust Silencers: Where exhaust silencers are mounted within enclosure in main engine compartment, insulate silencer to minimize heat dissipation as necessary for operation at rated load under worst case ambient temperature.

2.07 SOURCE QUALITY CONTROL

- A. See Section 01 4000 - Quality Requirements, for additional requirements.
- B. Perform production tests on generator sets at factory to verify operation and performance characteristics prior to shipment. Include certified test report with submittals.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that field measurements are as indicated.
- B. Verify that the ratings and configurations of generator sets and auxiliary equipment are consistent with the indicated requirements.
- C. Verify that rough-ins for field connections are in the proper locations.
- D. Verify that mounting surfaces are ready to receive equipment.
- E. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION

- A. Perform work in accordance with NECA 1 (general workmanship).
- B. Install products in accordance with manufacturer's instructions.
- C. Install generator sets and associated accessories in accordance with NECA/EGSA 404.
- D. Arrange equipment to provide minimum clearances and required maintenance access.
- E. Unless otherwise indicated, mount generator set on properly sized, minimum 6 inch (150 mm) high concrete pad constructed in accordance with Section 03 3000.
- F. Provide required support and attachment in accordance with Section 26 0529.
- G. Use manufacturer's recommended oil and coolant, suitable for the worst case ambient temperatures.
- H. Provide propane gas piping in accordance with Section 23 1126.
- I. Provide engine exhaust piping in accordance with Section 23 5100, where not factory installed.
 - 1. Include piping expansion joints, piping insulation, thimble, condensation trap/drain, rain cap, hangers/supports, etc. as indicated or as required.
 - 2. Do not exceed manufacturer's maximum back pressure requirements.
- J. Install exhaust silencer in accordance with Section 23 5100, where not factory installed.
- K. Provide grounding and bonding in accordance with Section 26 0526.
- L. Identify system wiring and components in accordance with Section 26 0553.

3.03 FIELD QUALITY CONTROL

- A. See Section 01 4000 - Quality Requirements, for additional requirements.
- B. Provide services of a manufacturer's authorized representative to prepare and start systems and perform inspection and testing. Include manufacturer's detailed testing procedures and field reports with submittals.
- C. Notify Owner and Engineer at least two weeks prior to scheduled inspections and tests.

- D. Notify authorities having jurisdiction and comply with their requirements for scheduling inspections and tests and for observation by their personnel.
- E. Provide all equipment, tools, and supplies required to accomplish inspection and testing, including load bank and fuel.
- F. Preliminary inspection and testing to include, at a minimum:
 - 1. Inspect each system component for damage and defects.
 - 2. Verify tightness of mechanical and electrical connections are according to manufacturer's recommended torque settings.
 - 3. Check for proper oil and coolant levels.
- G. Prepare and start system in accordance with manufacturer's instructions.
- H. Perform acceptance test in accordance with NFPA 110.
- I. Inspection and testing to include, at a minimum:
 - 1. Verify compliance with starting and load acceptance requirements.
 - 2. Verify voltage and frequency; make required adjustments as necessary.
 - 3. Verify phase sequence.
 - 4. Verify control system operation, including safety shutdowns.
 - 5. Verify operation of auxiliary equipment and accessories (e.g. battery charger, heaters, etc.).
 - 6. Perform load tests in accordance with NFPA 110 (1.5 hour building load test followed by 2 hour full load test).
- J. Provide field emissions testing where necessary for certification.
- K. Sound Level Tests: Measure sound levels for compliance with specified requirements. Identify and report ambient noise conditions.
- L. Correct defective work, adjust for proper operation, and retest until entire system complies with Contract Documents.
- M. Submit detailed reports indicating inspection and testing results and corrective actions taken.

3.04 CLEANING

- A. Clean exposed surfaces to remove dirt, paint, or other foreign material and restore to match original factory finish.

3.05 CLOSEOUT ACTIVITIES

- A. See Section 01 7800 - Closeout Submittals, for closeout submittals.
- B. See Section 01 7900 - Demonstration and Training, for additional requirements.
- C. Demonstration: Demonstrate proper operation of system to Owner, and correct deficiencies or make adjustments as directed.
- D. Training: Train Owner's personnel on operation, adjustment, and maintenance of system.
 - 1. Use operation and maintenance manual as training reference, supplemented with additional training materials as required.
 - 2. Provide minimum of four hours of training.
 - 3. Instructor: Manufacturer's authorized representative.
 - 4. Location: At project site.
- E. After successful acceptance test and just prior to Substantial Completion, replace air, oil, and fuel filters and fill fuel storage tank.

3.06 PROTECTION

- A. Protect installed engine generator system from subsequent construction operations.

END OF SECTION

SECTION 26 3623.16
AUTOMATIC/NONAUTOMATIC TRANSFER SWITCHES

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Low-voltage automatic/nonautomatic transfer switches.

1.02 RELATED REQUIREMENTS

- A. Section 03 3000 - Cast-in-Place Concrete: Concrete equipment pads.
- B. Section 26 3213 - Engine Generators.

1.03 ABBREVIATIONS AND ACRONYMS

- A. ATS: Automatic transfer switch.
- B. NTS: Nonautomatic transfer switch.

1.04 DEFINITIONS

- A. Automatic transfer switches may also be identified as ADGS, ADPS, ADRS, ADTS, ADUS, AGS, APS, ARS, ATS, or AUS.
- B. Nonautomatic transfer switches may also be identified as NDGS, NDPS, NDRS, NDTs, NDUS, NGS, NPS, NRS, NTS, or NUS.

1.05 REFERENCE STANDARDS

- A. IEC 60947-6-1 - Low-Voltage Switchgear and Controlgear – Part 6-1: Multiple Function Equipment – Transfer Switching Equipment; 2026.
- B. IEC 61000-4-2 - Electromagnetic Compatibility (EMC) - Part 4-2: Testing and Measurement Techniques - Electrostatic Discharge Immunity Test; 2025.
- C. IEC 61000-4-3 - Electromagnetic Compatibility (EMC) – Part 4-3: Testing and Measurement Techniques – Radiated, Radio-Frequency, Electromagnetic Field Immunity Test; 2020.
- D. IEC 61000-4-4 - Electromagnetic Compatibility (EMC) - Part 4-4: Testing and Measurement Techniques – Electrical Fast Transient/Burst Immunity Test; 2012.
- E. IEC 61000-4-5 - Electromagnetic Compatibility (EMC) - Part 4-5: Testing and Measurement Techniques - Surge Immunity Test; 2014, with Amendment (2017).
- F. IEC 61000-4-6 - Electromagnetic Compatibility (EMC) – Part 4-6: Testing and Measurement Techniques – Immunity to Conducted Disturbances, Induced by Radio-Frequency Fields; 2023.
- G. IEC CISPR 11 - Industrial, Scientific and Medical Equipment – Radio-Frequency Disturbance Characteristics – Limits and Methods of Measurement; 2024.
- H. ISO 9001 - Quality Management Systems — Requirements; 2015.
- I. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2023.
- J. NEMA IA 10042-1 - Industrial Control and Systems Part 1: Electromechanical AC Transfer Switch Equipment; 2025.
- K. NEMA PB 2.1 - General Instructions for Proper Handling, Installation, Operation, and Maintenance of Deadfront Distribution Switchboards Rated 1000 Volts or Less; 2023.
- L. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- M. NFPA 110 - Standard for Emergency and Standby Power Systems; 2025.
- N. UL 50 - Enclosures for Electrical Equipment, Non-Environmental Considerations; Current Edition, Including All Revisions.

- O. UL 50E - Enclosures for Electrical Equipment, Environmental Considerations; Current Edition, Including All Revisions.
- P. UL 891 - Switchboards; Current Edition, Including All Revisions.
- Q. UL 1008 - Transfer Switch Equipment; Current Edition, Including All Revisions.

1.06 ADMINISTRATIVE REQUIREMENTS

- A. Preinstallation Meeting: Review material selections and installation procedures with manufacturer's representative and affected installers.
- B. Scheduling: Do not schedule functional demonstration testing until operational readiness testing is complete and associated report and certification have been submitted.

1.07 SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements for submittal procedures.
- B. Provide sufficient information to determine compliance with Contract Documents. Identify submittal data with specific equipment tags and/or service descriptions to which they pertain. Identify specific model numbers, options, and features of equipment proposed.
- C. Product Data: Provide manufacturer's standard catalog pages and data sheets for each product, including ratings, configurations, dimensions, finishes, weights, service condition requirements, and installed features.
- D. Shop Drawings: Include dimensioned plan views and sections indicating locations of system components, required clearances, and field connection locations. Include system interconnection schematic diagrams showing factory and field connections.
- E. Manufacturer's qualification statement.
- F. Installer's qualification statement.
- G. Operation and Maintenance Data: Provide detailed information on system operation, equipment programming and setup, replacement parts, and recommended maintenance procedures and intervals.
- H. Executed warranty.
- I. Project Record Documents:
 - 1. Construction, installation, schematic, and wiring diagrams updated to as-installed and commissioned state.
 - 2. Configured settings/parameters for adjustable components updated to as-installed and commissioned state, noted if different from factory default.
- J. Maintenance Materials: Furnish the following for Owner's use in maintenance of project:
 - 1. See Section 01 6000 - Product Requirements for additional provisions.
 - 2. Spare Parts: For each type and size of unit installed.
 - a. Provide minimum spare parts recommended by manufacturer.
 - b. Identify the following:
 - 1) Contact information for closest parts stocking location to the Owner.
 - 2) Critical spare parts associated with long lead times and/or critical to unit's operation.
 - 3) Maintenance spares required to regularly perform scheduled maintenance, including but not limited to, consumable spares that are required to be exchanged during scheduled maintenance periods.
 - c. Fuses: One set of each type of power and control fuse installed within equipment.
 - d. Package and mark spare parts for long-term storage. Provide separate anti-static containers for printed circuit boards.
 - 3. Tools: Manufacturer-specific special tools required to install, remove, test, and maintain transfer switch components.

1.08 QUALITY ASSURANCE

- A. Comply with the following:
 - 1. NFPA 70.
 - 2. NFPA 110.
 - 3. Requirements of authorities having jurisdiction.
 - 4. Applicable local codes.
- B. Manufacturer Qualifications:
 - 1. Firm engaged in manufacture of specified products of types and sizes required, and whose products have been in satisfactory use in similar service for minimum of 10 years.
 - 2. Certified in accordance with ISO 9001 with applicable quality assurance system regularly reviewed and audited by third-party registrar. Develop and control manufacturing, inspection, and testing procedures under guidelines of quality assurance system.
 - 3. Service, repair, and technical support services available 24 hours per day, 7 days per week, 365 days per year from manufacturer or their representative.
 - 4. Maintain records of each switch, by serial number, for minimum of 20 years.
- C. Installer Qualifications: Firm with minimum 10 years experience with transfer switches of similar type and scope.
- D. Product Evaluation and Listing Organization Qualifications: Organization engaged in evaluation of products and services, including those recognized by OSHA as Nationally Recognized Testing Laboratories (NRTL), and acceptable to authorities having jurisdiction.

1.09 DELIVERY, STORAGE, AND HANDLING

- A. Receive, inspect, handle, and store switchboards in accordance with NEMA PB 2.1.
- B. Prior to delivery to project site, verify suitable storage space is available to store materials in well-ventilated area protected from weather, moisture, soiling, extreme temperatures, humidity, and corrosive atmospheres.
- C. Protect materials during delivery and storage and maintain within manufacturer's written storage requirements. At minimum, store indoors in clean, dry space with uniform temperature to prevent condensation and protect electronics from potential damage from electrical and magnetic energy.
- D. Deliver materials to project site in supplier's or manufacturer's original wrappings and containers, labeled with supplier's or manufacturer's name, material or product brand name, and equipment tag number or service name as identified in Contract Documents.
- E. Inspect products and report damage or violation of delivery, storage, and handling requirements to Engineer.

1.10 FIELD CONDITIONS

- A. Maintain field conditions within manufacturer's required service conditions during and after installation.

1.11 WARRANTY

- A. See Section 01 7800 - Closeout Submittals for additional warranty requirements.
- B. Manufacturer Warranty: Provide manufacturer warranty for defects in material and workmanship for 2 years from date of shipment. Complete forms in Owner's name and register with manufacturer.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Schneider Electric; ASCO Series 300 or 7000; www.se.com/us/en/brands/ascopower/#sle.
- B. RussElectric.

- C. Generator suppliers Automatic transfer switch.
- D. Substitutions: See Section 01 6000 - Product Requirements.
- E. Source Limitations: Provide automatic transfer switches, controllers, and accessories produced by same manufacturer as other electrical distribution equipment for project and obtained from single supplier.

2.02 LOW-VOLTAGE AUTOMATIC/NONAUTOMATIC TRANSFER SWITCHES

- A. Basis of Design: Schneider Electric; ASCO Series 300;
www.se.com/us/en/brands/ascopower/#sle.
- B. Description: Transfer switches consisting of inherently double-throw power transfer switch with solenoid-operated mechanism and microprocessor controller; automatic or nonautomatic operation as indicated.
 - 1. Automatic Transfer Switches: Transfer switches with automatically initiated transfer between sources.
 - 2. Nonautomatic Transfer Switches: Transfer switches with manually initiated transfer between sources.
- C. Comply with NEMA IA 10042-1 and IEC 60947-6-1; list and label in accordance with UL 1008 and, where applicable, UL 891.
- D. Automatic/Nonautomatic Transfer Switch:
 - 1. Non-Service-Entrance Switch:
 - a. Frame: 30 A to 230 A; open transition only.
 - b. Automatic Transition Configuration: Open transition.
 - c. Neutral Configuration: Switched neutral.
 - d. Phase Poles: As indicated on drawings.
 - e. Ampere Rating: As indicated on drawings.
 - f. Voltage: As indicated on drawings.
 - g. Enclosure: As required for installed location.
- E. Transfer Switch Construction:
 - 1. Electrically operated, mechanically held.
 - 2. Main operators which include overcurrent disconnect devices are not acceptable.
 - 3. Positively locked, unaffected by momentary outages, such that contact pressure is maintained at constant value and contact temperature rise is minimized for maximum reliability and operating life.
 - 4. Main Contacts: Silver composition.
 - 5. Designed to allow inspection of contacts from front without disassembly of operating linkages and disconnection of power conductors.
 - 6. Provide manual operating handle for maintenance that permits operator to manually stop contacts throughout their entire travel for inspection and service.
 - 7. Switches Rated 800 A and Greater: Provide segmented, blow-on construction for high withstand and close-on capability, protected by separate arcing contacts.
 - 8. Devices utilizing components of molded-case circuit breakers, contactors, or parts thereof, which are not intended for continuous duty, repetitive switching or transfer between two active power sources are not acceptable.
- F. Transition Modes:
 - 1. Open Transition:
 - a. Transfer load between power sources using 2-position, break-before-make switch.
 - b. Electrical Operator: Momentarily energized, single-solenoid mechanism.
 - c. Mechanically interlocked to allow only two possible positions, normal or emergency.
 - d. Main operators which include overcurrent disconnect devices are not acceptable.
 - 2. Delayed Transition:

- a. Transfer load between power sources using 2-position, break-before-make switch with user-defined interruption period in both directions.
 - b. Time Delay:
 - 1) Adjustable from 0 to 5 minutes and 59 seconds with 1-second resolution.
 - 2) Configured to be active for transfers or bypassed if voltage of load source drops below 70 percent of nominal.
 - c. Electrical Operator: Dual solenoid mechanism, momentarily energized.
 - d. Mechanically interlocked to allow only two possible positions, normal or emergency.
 - e. Main operators which include overcurrent disconnect devices are not acceptable.
- G. Withstand and Closing Ratings:
 - 1. Rate to close on and withstand available RMS symmetrical short circuit current at terminals with overcurrent protection indicated.
 - 2. Label with UL 1008, 0.025- or 0.050-second, time-based ratings, or appropriate short-time rating(s) as applicable. Transfer switches which have only series or specific-breaker ratings are not acceptable.
 - 3. Include 0.3-second, 18-cycle, short-time rating as standard for switch sizes 600 through 4,000 A for selective coordination purposes.
- H. Neutral Configurations:
 - 1. Solid Neutral: Provide neutral conductor plate with fully rated AL-CU pressure connectors.
 - 2. Switched Neutral: Provide fully-rated switched (break-before-make) neutral transfer contacts.
- I. Enclosures:
 - 1. Comply with UL 50.
 - 2. UL 50E Rating, Unless Otherwise Indicated:
 - a. Indoor Clean, Dry Locations: Type 1.
 - b. Outdoor Locations: Type 3R, Type 4, or Type 12.
- J. Pilot Devices:
 - 1. Provide LED indicating lights, consisting of one green LED to indicate when transfer switch is connected to normal source and one red LED to indicate when transfer switch is connected to emergency source.
 - 2. Provide LED indicating lights, energized by controller outputs to indicate true source availability of normal/emergency sources as determined by voltage sensing trip/reset settings for each source.
 - 3. Provide LED indicating light denoting manual operation when not in automatic mode and blinking amber to indicate transfer inhibit.
 - 4. Provide red LED indicating light to indicate alarm condition or active time delay.
- K. Controller:
 - 1. Construction:
 - a. Provide single, built-in microprocessor for controller's sensing and logic for maximum reliability and minimum maintenance.
 - b. Provide capability for serial communication through separate module.
 - c. Provide single controller with single- or three-phase capability for maximum application flexibility and minimal spare part requirements.
 - d. Connect controller to transfer switch with interconnecting wiring harness, including keyed disconnect plug to enable controller disconnection from transfer switch for routine maintenance.
 - e. Provide printed circuit boards for sensing and control logic.
 - f. Provide enclosure with protective cover mounted separately from transfer switch unit for safety and ease of maintenance.
 - 2. Voltage Sensing: True RMS, accurate to within plus/minus 1 percent of nominal voltage.
 - 3. Frequency Sensing: Accurate to within plus/minus 0.1 Hz.

4. Time Delay: Accurate to within plus/minus 0.5 percent of full-scale value.
5. Service Conditions:
 - a. Ambient Operating Temperature: Between minus 4 degrees F (minus 20 degrees C) and 140 degrees F (60 degrees C).
6. Electromagnetic Compatibility (EMC):
 - a. IEC CISPR 11, Group 1, Class A.
 - b. IEC 60947-6-1.
 - c. IEC 61000-4-2.
 - d. IEC 61000-4-3.
 - e. IEC 61000-4-4.
 - f. IEC 61000-4-5.
 - g. IEC 61000-4-6.
7. Controller Display/Keypad:
 - a. Provide integral 128 x 64 graphical LCD display and keypad for viewing available data and setting operational parameters.
 - b. Make operational parameters available for viewing and limited control through serial communications input port.
 - c. Make the following operational parameters adjustable only via controller DIP switches:
 - 1) Nominal line voltage and frequency.
 - 2) Single- or three-phase sensing.
 - 3) Transfer operating mode configuration (open or delayed transition).
 - d. Controller Instructions and Settings: Accessible, readable, and accomplished without use of codes, calculations, or instruction manuals.
8. Provide the following integral features, capable of being activated through keypad programming:
 - a. Commit to Transfer: Selectable to determine whether load should be transferred to emergency generator if normal source restores before generator is ready to accept load.
 - b. In-Phase Monitor (Open Transition Only):
 - 1) Control transfer such that motor load inrush currents do not exceed normal starting currents, without requiring external control of power sources.
 - 2) Product of transfer switch manufacturer.
 - c. Engine Exerciser:
 - 1) Enables user to program up to seven different exercise routines.
 - 2) Programmable Routine Parameters:
 - (a) Configure weekly and bi-weekly automatic testing of engine generator set with or without load for 20 minutes fixed.
 - (b) Start Time: Configured to indicate day of week and time of weekly testing.
 - d. Provide terminals for remote contact which close to signal transfer to emergency source and for remote contacts which open to inhibit transfer to emergency.
 - e. System Status: Provide system status screen for controller LCD display, accessible from menu by pressing "ESC" key. Display clear description of active operating sequence and switch position, such as 'Normal Failed; Load on Normal; TD Normal to Emergency; 2 min 15 s'.
 - f. Controllers requiring multiple screens to determine system status or display coded system status messages are not permissible.
 - g. Self-Diagnostics: Provide diagnostics screen for detecting system errors. Provide information on status input signals to controller, which may prevent load transfer commands from being completed.
 - h. Data Logging: Log data, storing previous 99 events in nonvolatile memory, retained in event of total power loss; include the following:

- 1) Event Logging:
 - (a) Data, time, and reason for transfer from normal to emergency.
 - (b) Data, time, and reason for transfer from emergency to normal.
 - (c) Data, time, and reason for engine start.
 - (d) Data and time engine stopped.
 - (e) Data and time emergency source available.
 - (f) Data and time emergency source not available.
 - 2) Statistical Data:
 - (a) Total number of transfers.
 - (b) Total number of transfers due to source failure.
 - (c) Total number of days controller has been energized.
 - (d) Total number of hours both normal and emergency sources have been available.
 - (e) Total time load is connected to normal.
 - (f) Total time load is connected to emergency.
 - (g) Last engine start.
 - (h) Last engine start-up time.
 - (i) Input and output status.
 - i. Test/Reset Modes:
 - 1) Test Mode: Simulate normal source failure.
 - 2) Reset Mode: Bypass time delays on transfer to emergency or retransfer to normal.
- L. Voltage, Frequency, and Phase Rotation Sensing:
1. Voltage and Frequency Sensing: Continuously monitored on normal and emergency sources with the following minimum pickup and dropout/trip capabilities:
 - a. Undervoltage:
 - 1) Sources: Normal and emergency.
 - 2) Dropout/Trip: 70 to 98 percent.
 - 3) Pickup/Reset: 85 to 100 percent.
 - b. Overvoltage:
 - 1) Sources: Normal and emergency.
 - 2) Dropout/Trip: 102 to 116 percent.
 - 3) Pickup/Reset: 2 percent below trip.
 - c. Under Frequency:
 - 1) Sources: Normal and emergency.
 - 2) Dropout/Trip: 85 to 98 percent.
 - 3) Pickup/Reset: 86 to 100 percent.
 - d. Over Frequency:
 - 1) Sources: Normal and emergency.
 - 2) Dropout/Trip: 101 to 111 percent.
 - 3) Pickup/Reset: 2 percent below trip.
 2. Repetitive Accuracy of Settings: Within plus/minus 1 percent over operating temperature range of 77 degrees F (25 degrees C).
 3. Voltage and Frequency Settings: Field adjustable in 1-percent increments locally via display/keypad or remotely via serial communications port access.
 4. Source Status Screens: For normal and emergency sources, display digital readout of voltage on each phase, frequency, and phase rotation.
- M. Time Delays:
1. Provide adjustable time delay of 0 to 6 seconds for override of momentary normal source outages and delay of transfer and engine starting signals. Provide capability to bypass time delay from controller user interface.

2. Provide time delay on transfer to emergency, adjustable from 0 to 60 minutes, 59 seconds, for controlled timing of load transfer to emergency source. Provide capability to bypass time delay from controller user interface.
3. Provide generator stabilization time delay after transfer to emergency, adjustable from 0 to 4 seconds.
4. Provide time delay on retransfer to normal source, adjustable from 0 to 9 hours, 59 minutes, 59 seconds. Automatically bypass time delay if emergency source fails and normal source is acceptable.
5. Provide time delay on shut down of engine generator for cool down, adjustable from 0 to 60 minutes, 59 seconds.
6. Provide time-delay-activated output signal to drive external relays for selective load disconnect control; capable of activating adjustable time delay of 0 to 5 minutes, 59 seconds in following modes:
 - a. Prior to transfer only.
 - b. Prior to and after transfer.
 - c. Normal to emergency only.
 - d. Emergency to normal only.
 - e. Normal to emergency and emergency to normal.
 - f. All transfer conditions or only when both sources are available.
7. If alternate source is not accepted within configured Failure to Accept time delay, activate common alert indication.
8. Adjustable time delays to be capable of field adjustment without use of special tools.
- N. Provide SPDT contact, rated 5 A at 30 VDC, for low-voltage engine start signal; prevents dry cranking of engine by requiring generator set to reach proper output and run for duration of cool-down setting, regardless of whether normal source restores before load is transferred.
- O. Provide auxiliary contacts, rated 10 A at 250 VAC, consisting of one contact which is closed when transfer switch is connected to normal source and one contact which is closed when transfer switch is connected to emergency source.
- P. Provide single alarm indication to light alert indicator and de-energize configured common alarm output relay for external monitoring.

2.03 SOURCE QUALITY CONTROL

- A. See Section 01 4000 - Quality Requirements for additional requirements.
- B. Factory test for proper operation of individual components and compliance with sequence of operation. Verify operating transfer time, voltage, frequency, and time delay settings.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Examine equipment exterior and interior for damage, including but not limited to, structure, moisture, and mildew.
- B. Examine for conditions detrimental to completion of work.
- C. Do not proceed with work until unsatisfactory conditions have been corrected.

3.02 INSTALLATION

- A. Install equipment in accordance with manufacturer's written instructions.
- B. Install transfer switches in accordance with NECA 1.
- C. Unless otherwise indicated, install and anchor floor-mounted transfer switches on raised concrete pad 4 inches (100 mm) high; see Section 03 3000.

3.03 FIELD QUALITY CONTROL

- A. See Section 01 4000 - Quality Requirements for additional requirements.

- B. Manufacturer Services: Provide services of manufacturer's field representative to perform functional testing, commissioning, and first parameter adjusting.
 - 1. Include necessary material, equipment, labor, and technical supervision.
 - 2. Replace damaged or malfunctioning equipment and report discrepancies or installation issues.
 - 3. Identify transfer switches with label indicating inspection/testing agency and date of service.
- C. Correct deficiencies and replace damaged or defective transfer switches or associated components.

3.04 CLOSEOUT ACTIVITIES

- A. See Section 01 7800 - Closeout Submittals for additional submittals.
- B. See Section 01 7900 - Demonstration and Training for additional requirements.
- C. Functional Demonstration Testing: Demonstrate proper operation of transfer switches and associated systems to Owner's designated representative and Engineer, observing and documenting compliance with Contract Documents.
- D. Training:
 - 1. Train Owner's personnel on operation and maintenance of system.
 - a. Accommodate minimum of four attendees.
 - b. Provide not less than one session(s) with four hours of classroom and hands-on training.
 - c. Training Reference: Use submitted operations and maintenance manuals.
 - d. Instructor: Factory-trained manufacturer's representative.
 - e. Location: Project site.
 - 2. Provide sufficient time and detail in each session to cover the following at minimum:
 - a. Operation theory.
 - b. Major equipment components.
 - c. Equipment operation.
 - d. Equipment configurations.
 - e. Maintenance, troubleshooting, and repair.
 - f. Component-level parts replacement.

3.05 PROTECTION

- A. Protect installed transfer switches from subsequent construction operations.

END OF SECTION

**CONTRACT #2
SECTION 33 09 00**

PLC & SCADA CONTROL SYSTEMS

PART 1 GENERAL

1.01 SUMMARY

- A. This Section covers includes the general requirements for furnishing, installing, programming, adjusting, testing, documenting and commissioning of complete and operational SCADA and PLC based control systems. The control system includes (1) one PLC control systems, communications, control devices, motor control and instrumentation for complete control and monitoring of the (1) one control building. Both control systems shall be integrated into the OWNERS existing central SCADA system.

1. Chemical Control Building (CP-2)

- B. Related Sections:

1. Section 26 00 01 – Electrical Systems
2. Section 33 09 01 – Instrumentation for Control Systems
3. Section 33 09 30 – Chlorine PH Measurement and Control Instrumentation
4. Section 33 21 40 – Chemical Metering Pumps

1.02 REFERENCES

- 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. 47 CFR 15 Radio Frequency Devices
2. IEEE C62.41 Surge Voltages in Low-Voltage AC Power Circuits

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION
(NEMA)

1. NEMA 250 Enclosures for Electrical Equipment (1000 Volts Maximum)

2. NEMA AB 1 Molded Case Circuit Breakers and Molded Case Switches
3. NEMA ICS 1 Industrial Controls and Systems
4. NEMA ICS 2 Industrial Control Devices, Controllers and Assemblies
5. NEMA ICS 4 Industrial Control and Systems: Terminal Blocks
6. NEMA ICS 6 Enclosures for Industrial Control and Systems
7. NEMA ST1 Standard for specialty transformers

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

1. NFPA 70 National Electrical Code
2. NFPA 780 Installation of Lightning Protection Systems
3. NFPA 810 Radio and Television Equipment

UNDERWRITERS LABORATORIES (UL)

1. UL 50 Enclosures for Electrical Equipment
2. UL 83 Thermoplastic-Insulated Wires and Cables
3. UL 94 Tests for Flammability of Plastic Materials for Parts in Devices and Appliances
4. UL 444 Standards for Communication Cables
5. UL 467 Grounding and Bonding Equipment
6. UL 486A Wire Connectors and Soldering Lugs for Use with Copper Conductors
7. UL 489 Molded-Case Circuit Breakers and Circuit-Breaker Enclosures
8. UL 508 The Standard for Industrial Control Equipment
9. UL 508A Outline of Investigation for Industrial Control Panels
10. UL 698 Industrial Control Equipment for Use in Hazardous (Classified) Locations
11. UL 886 Outlet Boxes and Fittings for Use in Hazardous

Locations

12. UL 913 Intrinsically Safe Apparatus and Associated Apparatus for Use in Class I, II, and III, Division I Hazardous Locations
13. UL 1063 Machine Tool Wires and Cables
14. UL 1092 Process Control Equipment
15. UL 1203 Explosion Proof and Dust Ignition Proof Electrical Equipment for Use in Hazardous Locations
16. UL 1449 Standard for Transient Voltage Surge Suppression
17. UL 1604 Electrical Equipment for Use in Hazardous Locations, Class I and Class II, Division 2 and Class III, Divisions 1 and 2
18. UL 1778 Uninterruptible Power Supply Equipment
19. UL 2225 Standard for Metal-Clad Cables and Cable Sealing Fittings for Use in Hazardous Locations
20. UL 2279 Electrical Equipment for Use in Class I, Zone 0, 1, and 2 Hazardous Locations

1.03 DEFINITION OF TERMS

- A. BOM – Bill of Materials
- B. CHEMCP – (CP-2) Chemical Control Building PLC System
- C. Contractor – PLC and SCADA control system integrator/contractor
- D. CP – Control Panel
- E. IFB – Issued For Bid
- F. IFC – Issued For Construction
- G. I/O – PLC Inputs and Outputs
- H. FAT – Factory Acceptance Test
- I. HMI – Human Machine Interface (Operator Screen)
- J. MFG – Manufacturer
- K. OEM – Original Equipment Manufacturer

- L. O&M – Operations and Maintenance
- M. PLC – Programmable Logic Controller
- N. PS – Pump Station
- O. SAT – Site Acceptance Test
- P. SCADA – Supervisory Control And Data Acquisition system
- Q. SCP – Station Control Panel System
- R. VFD – Variable Frequency Drive

1.04 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 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 on their staff with their bid demonstrating this requirement.
- D. The Contractor shall be experienced with the programming and commissioning of the respective PLC, HMI, Motor Control and SCADA systems. Contractor shall provide supporting documentation with their bid demonstrating this requirement.
- E. The Contractor or Contractor's vendor shall be experienced with the configuration, selection, testing and commissioning of a data radio and antenna systems. Contractor shall provide supporting documentation with their bid demonstrating this requirement.
- F. The Contractor shall become familiar with all details of the work and verify any required dimensions and distances. Contractor shall understand and document as needed any existing power panels, field wiring, 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.

1.05 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 (5) years prior to bid opening.
- B. No product shall be manufactured in or originate from China.

1.06 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.

1.07 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 design respective Control Panel drawings in AutoCAD including back panel layout, front door layout, Bill of Materials, power distribution and grounding, motor control, PLC input and output card drawings, network/system architecture.
 - 2. Contractor shall furnish, assemble, test and install each control system in accordance with respective IFC design drawings,

specifications, and testing requirements.

3. Contractor shall create custom PLC, HMI and communications user programs for the CHEMCP as outlined.
4. Contractor shall furnish and install all radio antennas, masts, ground kits, weather kits and poly phase surge protection at each building for the CHEMCP.
5. Contractor shall provide Submittals as outlined.
6. Contractor shall coordinate and execute the FAT at their facility.
7. Contractor shall ensure that each respective radio is online and fully functioning with any existing OWNER radio systems and OWNER SCADA as part of system commissioning.
8. Contractor shall coordinate and execute the SAT onsite.
9. Contractor shall redline the IFC drawings with any changes made during construction, FAT, SAT and operational testing for OWNER's incorporation into an As-Built set of drawings.
10. Contractor shall provide Spare Parts as outlined.
11. Contractor to provide all electrical permits and inspections as required by the State, County, and City.
12. Contractor shall provide (1) one day of onsite system training for the OWNER. Training shall be on regular business days from 8 am to 3:00 pm.

1.08 SUBMITTALS

A. Shop Drawings

1. Contractor shall submit manufacturers data sheets for OWNER review and consideration, any material, part or equipment substitutions/modifications requests prior to making a change.
2. Contractor shall submit for OWNER review and consideration, any material, part or equipment substitutions/modifications requests prior to making a change.

B. 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 an electronic copy in pdf.
3. OWNER review and approval is required on all shop drawings.

C. HMI Screen Submittals

1. The Contractor shall provide a pdf of all HMI screens utilized in the respective control panel. HMI screen submittal is required for review and approval prior to FAT execution. The screen shall represent the Contractor's final checked version and represent all the screens for the respective control panel.

D. Control Panel Drawing Submittals

1. Following approval of the shop drawing submittals, the Contractor shall provide a complete set of each respective Control Panel set of drawings. Submit an electronic copy in pdf.

E. FAT Test Plan

1. Contractor shall submit an electronic copy in pdf of the FAT plan, descriptions and test execution spreadsheets that will be executed.

F. SAT Test Plan

1. Contractor shall submit an electronic copy in pdf of the SAT plan, description and test execution spreadsheets that will be executed.

1.09 OPERATION AND MAINTENANCE MANUALS

- A. Provide Operation and Maintenance (O&M) data for the completed control system. Provide (2) two copies of the 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. By Control System Panel - control panel functions and indicator descriptions.
3. By Control System Panel - operations and procedures.
4. By Control System Panel - 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
6. Steps to restarting the PLC and Radio system from a cold start such as utility power failure and UPS failure/battery drain.

1.10 PLC INPUT OUTPUT LISTS

a. The list(s) on the next page are for reference and do not represent all required PLC I/O. Contractor shall determine through the control panel design process the actual I/O required and number and type of I/O cards.

(CP-2) CHEMICAL BUILDING PLC / MOTOR STARTER PANEL I/O LIST		
TAG	TYPE	DESCRIPTION
FT-50	AI	Mag Flow Meter Flow Rate
TT-50	AI	Building Temperature
AIT-50	AI	Ortho Analyzer
AIT-51	AI	PH Analyzer
AIT-52	AI	Chlorine Analyzer
SY-60	AO	Ortho Phosphate Chemical Pump Flow Pace Command
SY-61	AO	Chlorine Chemical Pump Flow Pace Command
XI-60	DI	Ortho Phosphate Chemical Status
XI-61	DI	Chlorine Chemical Pump Status
XI-80	DI	Door Intrusion sensor 1
XI-81	DI	Door Intrusion sensor 2
XI-82	DI	Door Intrusion sensor 3
XI-83	DI	Door Intrusion sensor 4
XI-84	DI	Door Security Key switch in Armed
XI-85	DI	Door Security Key switch in Disarmed
XI-86	DI	PLC Input Power Ok
XI-87	DI	Utility Power Ok
XI-88	DI	UPS on Battery
XI-89	DI	Control Panel Temperature Alarm
XI-90	DI	ATS on Back up Generator
HOA-100A	DI	Manganese Lift Station Pump #1 HOA in AUTO MODE
XI-100A	DI	Manganese Lift Station Pump #1 Running (Motor Starter)
XA-100	DI	Manganese Lift Station Pump #1 Overload (Motor Starter)
XI-100B	DI	Manganese Lift Station Pump #1 Run Feedback (CT Switch)
HOA-200A	DI	Manganese Lift Station Pump #2 HOA in AUTO MODE
XI-200	DI	Manganese Lift Station Pump #2 Running (Motor Starter)
XA-200	DI	Manganese Lift Station Pump #2 Overload (Motor Starter)
XI-200B	DI	Manganese Lift Station Pump #2 Run Feedback (CT Switch)
XI-101	DI	Manganese Lift Station Pump #1 Motor Seal Fail (MiniCas or other)
XI-102	DI	Manganese Lift Station Pump #1 Motor OverTemp (MiniCas or other)
XI-201	DI	Manganese Lift Station Pump #2 Motor Seal Fail (MiniCas or other)
XI-202	DI	Manganese Lift Station Pump #2 Motor OverTemp (MiniCas or other)
LS-50	DI	Manganese Lift Station - Pump Off Float
LS-51	DI	Manganese Lift Station - Pump On Float
LS-52	DI	Manganese Lift Station - Lag Pump On Float
LS-53	DI	Manganese Lift Station - High level Alarm Float
XI-300		Filtration System Faulted (from vendor Panel)
LY-50	DO	Outside Building Red Status Light
HRN-50	DO	Warning Horn (Mounted on control panel)
XY-60	DO	Ortho Phosphate Chemical Pump Remote Start
XY-61	DO	Chlorine Chemical Pump Remote Start
XY-100	DO	Manganese Lift Station Pump #1 Start Command (Motor Starter)
XY-200	DO	Manganese Lift Station Pump #2 Start Command (Motor Starter)
HOA-100H	Hardwired	Manganese Lift Station Pump #1 - HAND MODE (Hardwired to Starter)
HOA-200H	Hardwired	Manganese Lift Station Pump #2 - HAND MODE (Hardwired to Starter)
	Radio- 2	Communication to Pump Control Building PLC panel
	Radio -2	Communication to Water Group

1.11 SPARE PARTS

- A. Spare parts shall be furnished as specified below. Provide a Spare Parts line item cost. 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 of each type used)
 2. PLC Output Card (Qty. 1 of each type used)
 3. PLC Input Card (Qty. 1 of each type used)
 4. PLC Analog Input Card (Qty. 1 of each type used)
 5. Control Panel UPS (Qty. 1 of each type used)
 6. 24 Vdc Power Supply (Qty. 1 of each type used)
 7. Radio (Qty. 1 of each type used)
 8. Antenna Polyphase Surge Suppressor (Qty. 2)

PART 2 PRODUCTS

2.01 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.

2.02 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. (1) PLC Control Panels
 2. (1) Front Door Mounted HMI screens
 3. (1) Control Panel 120VAC UPSs
 4. (1) Radios
 5. (1) Antennas, masts, cable systems, connectors, and ground/weather kits.

6. Instrumentation and analytical equipment

2.03 PLC CONTROL PANELS

- 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 Panel Enclosures

- a. The enclosure shall be a UL listed enclosure constructed to NEMA 4 painted steel specifications. All doors shall have a locking hasp or a key lock handle. Provide two keys per lock. The enclosure back panel shall include a 20% additional capacity for future components. A removable white painted steel inner panel shall be provided for the mounting of equipment devices. A print holder shall be provided inside the door. Removable lifting means shall be provided to facilitate handling of all panels weighing over 200 pounds or exceeding 10 cubic feet in volume.

- b. The enclosure shall be floor standing. Provide the enclosure manufacturers stand kit of same material where the enclosure does not come with integral feet.
 - c. Contractor shall determine enclosure height, width and depth based on back-panel and front door mounted devices. In addition the contractor shall verify available wall and floor space in the respective building to determine enclosure dimensions.
 - d. Saginaw or Approved Equivalent
3. Control Wiring
- a. Wire shall be color coded as follows:
 - AC Line & Load: Black
 - AC Control: Red
 - Neutral: White
 - DC + Power: Blue
 - DC Control: Blue
 - DC - Common: White/blue stripe
 - Mechanical Ground: Green or Green/Yellow Stripe
 - Control Wiring Powered from Other Sources: Yellow
 - b. Conductor size shall be as outlined on design drawings. Where not indicated it shall be #14 or larger (as required). All control, interface and power wire terminating in the respective control panel shall be stranded wire type THHN, heavy wall except where otherwise indicated. DC control wiring shall be stranded #16 AWG or larger except where otherwise indicated.
 - c. All instrumentation and analog shielded cables shall be stranded #18 AWG with a 100% coverage shield and drain wire, 150 volt insulation except where otherwise indicated. Terminate and ground shield and drain wire as indicated on drawings. 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. Terminal block color shall be as outlined on the design drawings. 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. The wiring duct size shall be as indicated on drawings. Wiring duct and covers shall be from the same manufacturer.

6. High Rise DIN Rail

- a. High Rise mounting rail shall be used for all terminal block mounting. The rail shall be constructed of aluminum with a height of 2 to 3 inches. The rail shall be designed for use with DIN rail terminal blocks.

7. Standard Rail

- a. Standard DIN rail shall be used to mount all DIN mountable devices except terminal blocks. The standard DIN rail shall be constructed of rigid aluminum or zinc plated steel. The rail shall be designed for use with all rail mounted panel components.

8. Control Panel Enclosure Fan(s)

- a. The fan(s) shall have an outer removable stainless-steel cover with a replaceable type filter element. The contractor shall determine fan size (CFM) based on the calculated total heat load of the respective panel components and the highest ambient temperature of the panel location. Provide one spare filter element per unit.

- b. Fan package shall be from Enclosure Manufacturer
- 9. Control Panel Thermostats
 - 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.
- 10. Control Relays
 - a. The control relay coil voltages shall be as required (24VDC or 120VAC). 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. The overall dimensional data will not require adjusting the design drawing layout. All control relays shall be from the same manufacturer.
 - b. Allen Bradley or Approved Equivalent
- 11. 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.
- 12. 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. Single pole circuit breakers shall be from the same manufacturer.
- 13. 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.

14. Network Switch

- a. The Ethernet switch shall have the required RJ45 ports plus 2 spare ports supporting a transmission speed of 10/100 Mbps with autodetect and negotiation. Front facing diagnostic/status LEDs. Unit is designed for direct DIN rail mount. The overall dimensional data including cooling space as required by the manufacturer will not require adjusting the design drawing layout. 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.
- b. Phoenix Contact or Approved Equivalent

15. 24 Vdc Power Supplies

- a. The 24 Vdc power supplies shall be 120 Vac powered and provide 24 Vdc and sized in amps to power devices with a minimum of 25% spare current capacity output. 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 DIN rail mounted devices. 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. Sola or Approved Equivalent

16. Uninterruptible Power Supply

- a. The uninterruptible power supply shall be rated for

120VAC with a 750VA capacity. The unit shall be a self-contained unit with a 3 foot, NEMA 5-15P male plug and a minimum of 2 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 6 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 unit shall have full time EMI and RFI filtering and surge protection. The UPS shall be located in the bottom of the control panel enclosure and sized such that it doesn't obstruct or interfere with the view or adjustment of back panel and front door mounted devices.

- b. APC or Approved Equivalent

17. Control Panel Pilot Lights

- a. Pilot lights shall be 120 VAC or 24 VDC rated with high intensity LED cluster lamps. The units shall have the same NEMA rating as the control panel enclosure. 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 follow this methodology:
- Control Power On – Green (note 1)
 - Emergency Stop – Red Mushroom Head, Maintained Operator (Note 1)
 - Equipment or Device General Fault/Alarm Light – Red (Note 1)
 - Equipment or Device Running – Green (Note 1)
 - Valve Open – Green (Note 2)
 - Valve Closed – Red (Note 2)
 - High and Low Level – Red (Note 2)

- High and Low Flow – Red (Note 2)
- High and Low Temperature – Red (Note 2)

Note 1 – Always Required

Note 2 – Not required when providing an HMI screen on the enclosure front door that indicates the respective status and feedback.

- b. Pilot Lights shall be from the same manufacturer, model type as other front door mounted devices on all control panels.
- c. Allen Bradley or Approved Equivalent

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.
 - Control Power On – Green (note 1)
 - Emergency Stop – Red Mushroom Head, Maintained Operator (note 1)
 - General Fault/Alarm Reset – Black (Note 1)
 - Motor Start – Green (Note 1)
 - Motor Stop – Red (Note 1)
 - Equipment or Device Start – Green (Note 2)
 - Equipment or Device Stop – Red (Note 2)

Note 1 – Always Required

Note 2 – Not required when providing an HMI screen on the enclosure front door that provides the respective control function.

- b. Pushbuttons shall be from the same manufacturer, model type as other front door mounted devices on all control panels.
- c. Allen Bradley or Approved Equivalent

19. Control Panel Two/Three Position Selector Switches

- a. Position 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 two position maintained operator with the key lock in both positions. The units shall have the same NEMA rating as the control panel enclosure. They shall have a minimum diameter of 30mm, NEMA style. Provide “no spin” locking ring washer. Three position selector switches are required for all motors, pumps, and motor operated devices to facilitate HAND OFF AUTO mode control.

- b. Selector switches shall be from the same manufacturer, model type as other front door mounted devices on all control panels.
- c. Allen Bradley or Approved Equivalent

20. Motor Starters

- a. Motor starters shall be IEC or NEMA rated starters. The overload and starter shall be intended to be used together by the manufacturer. The starter shall have an auxiliary N.O. contact for the PLC to monitor the run status of the starter. The motor starter coil shall be 120VAC unless otherwise specified. The starter contacts shall be rated for a minimum of 1 million cycles at intended current usage for the AC-3 category. IEC type motor starters shall be sized with a 30% additional current load capacity.
- b. Allen Bradley or Approved Equivalent

21. Motor Overloads

- a. The overload and starter shall be intended to be used together by the manufacturer. The overload shall electrically interlock the starter with a N.C. contact. The overload shall have an auxiliary N.O. contact for the PLC to monitor the overload status of the motor overload and an additional contact to interlock the starter from being energized. The overload shall have an adjustable trip range to allow field setting of the trip.
- b. Allen Bradley or Approved Equivalent

22. AC Motor Current Sensing Relay

- a. The CT sensing relay shall be a panel mounted enclosed

device with a CT loop to monitor one phase of the motor.

The sensing relay shall be self powered and not require adjustment or calibration. The relay shall be sized according to the respective motor current it will be monitoring. The switch shall close when it detects the required motor current indicating a run condition. This switch is required for all motors controlled by motor starters. Each respective switch shall be monitored by the PLC digital input.

- b. RK Electronics or Approved Equivalent

23. Variable Frequency Drives (VFD)

- a. Allen Bradley, ABB or Approved Equivalent
- b. VFD Sizing

The FLA output rating of the VFD shall meet or exceed the actual motor nameplate of the connected load with the exception of the following specific sizes;

0.5 to 1.0 HP motors – 1 HP rated VFD

1.5 to 2.0 HP motors – 2 HP rated VFD

3.0 HP to 5.0 HP - 5 HP rated VFD

- c. VFD Enclosure and Mounting

NEMA 1 rated housing where installed inside a NEMA 12, 13, 3R, 4 or 4X rated panel enclosure. The VFD shall be designed to be mounted inside a control panel enclosure with a maximum of 2 inches of space required on the top and the bottom for ventilation without output current de-rating. The VFD shall be rated for zero clearance mounting on both sides.

- d. VFD Communications

Integral EtherNet/IP and RS485 ports. All of the VFD internal commands and status words shall be accessible without additional interfaces or communication protocols to the PLC CPU.

- e. VFD Onboard Inputs and Outputs

The VFD shall have built or plug-in modular type cards that provide PLC accessible digital and analog inputs and outputs. Minimum of six (6) programmable 24VDC

digital inputs, four (4) 24VDC or relay programmable digital outputs. Minimum of (2) analog inputs scalable for 0-10VDC and 4-20mA with a minimum of 10 bit resolution. Minimum of (1) analog outputs scalable for 0-10VDC and 4-20mA with a minimum of 10 bit resolution.

f. VFD Control

The VFD has the option of being controlled from PLC software commands over Ethernet or hardwired commands wired into the VFD IO. Control is defined as speed, selectable acceleration times, selectable deceleration times, start, and stop.

A minimum of four (4) accel and decel modes can be programmed in a range of 0 to 600 seconds in 0.1 increments. Stop modes shall include selection of Ramp, Coast, DC-Brake and Ramp to Stop.

g. VFD Keypad Interface

All VFDs shall have the same manufacturer keypad interface regardless of horsepower rating. The keypad shall be removable from the VFD with a cable for remote mounting on the front door of the panel enclosure. The keypad interface shall have the same NEMA rating as the panel enclosure. The keypad will have a display and provide a means for an operator to allow program parameter settings and run the VFD in a manual mode (HAND) without the need for PLC control.

The keypad shall provide a means to view historical fault codes and times. All applicable operating values shall be capable of being displayed in engineering (user) units. The display shall be in complete English words (alpha-numeric codes are not acceptable):

- Output Frequency
- Motor Speed (RPM, %, or Engineering units)
- Motor Current
- Drive Temperature
- DC Bus Voltage
- Output Voltage

h. VFD Electrical

The line in voltage tolerance shall be a minimum of -15%

and +10%. Power blip ride through shall be at least 100ms. The line in frequency tolerance shall be a minimum of range of 50Hz to 63Hz. Maximum short circuit rating of 60,000 amps symmetrical. shall operate on a line voltage overload rating of the drive shall be 150% of its normal rated duty current for 60 seconds.

i. VFD Electrical Protection

The overload rating of the drive shall be 150% of its normal rated duty current for 60 seconds and 200% for 3 seconds. The VFD shall have a built in ground fault trip that detects phase to ground. The VFD shall have a built in phase to phase (short circuit) fault trip.

j. VFD Environmental

Continuous operating temperature from 0 Deg F to 120 Deg F without output current de-rating. Continuous operating at altitudes of 0 to 3300 feet above sea level and up to 95% humidity, non-condensing without output current de-rating.

24. VFD Line & Load Reactors

- a. The VFD line reactor shall be sized according to the HP rating of the respective connected VFD. They shall be rated for line voltage with finger safe line and lug terminals. They shall be rated for 3% impedance. They shall be an open type and recommended for mounting and use inside an enclosure.
- b. The VFD load reactors shall be as specified in the VFD manufacturers installation requirements based on the length of the VFD shielded motor cable for the respective installation.

25. Main Disconnect

- a. The VFD panel main disconnect shall be a flange mount type suitable for direct mounting on the enclosure manufacturers flange mount knockout. The disconnect handle shall be a flexible cable type with all required mounting and cable operator hardware. The disconnect shall be a non-fusible type complete with the manufacturers rated line and lug kits. The operator handle shall be all metal with an equal or better NEMA

rating than the panel enclosure. Current and voltage rating of the disconnect shall be as required based on total motor and control panel load.

- b. Square D or Approved Equivalent

26. Main Circuit Breaker

- a. The motor branch circuit breaker shall be rated for the line voltage of the motors and recommended for mounting and use inside an enclosure. The circuit breaker trip rating shall be sized for a minimum of 150% of the respective total connected motor and panel current. The circuit breaker shall have standard magnetic trip and a minimum short circuit rating of 50kA.

27. Power Distribution Block

- a. Distribution blocks shall be rated for line voltage and recommended for mounting and use inside an enclosure. The block shall be sized for a minimum of 150% of the respective total connected motor and panel current. They shall have a finger safe cover over the line and load lugs and block.

28. Intrinsically Safe Barriers

- a. Intrinsically safe interfaces shall be used on all field mounted components located in a hazardous location. The intrinsically safe devices shall be selected by the contractor based on the field devices conductor quantity, primary side voltage, and current requirements.

2.04 PLC SYSTEM

A. PLC Hardware

1. All PLC hardware shall be Allen Bradley CompactLogix or approved equivalent.
2. PLC CPU: Allen Bradley 5380 5069-L320ER Processor
3. PLC I/O: Provide CompactLogix Digital Input & Output, Analog Input & Output cards as required for the respective number and type of terminations. Include a minimum of 25% spare on each type of card.
4. Provide all required cables and pre-loaded development software

and licenses for a complete and operational system.

5. Contractor shall program, test and commission the HMI in accordance with these specifications.

B. HMI Screen:

1. HMI screen shall be Allen Bradley FactoryView 7 Plus with a 6" color screen, Ethernet and USB connectivity, NEMA 4X rated, front door mount, 512MB or approved equivalent.
2. Provide all required cables and pre-loaded development software and licenses for a complete and operational system.
3. Contractor shall program, test and commission the HMI in accordance with these specifications.

C. Programming of PLC and HMI

1. The Contractor shall provide all programming, functional testing and commissioning for the entire control system according to the descriptions in this specification and design drawing features and place the complete system into operation.
2. Adjustments or additional required sequence interlocks, alarming, or minor graphic features added during testing and commissioning shall be included in the bid price.
3. The Contractor shall provide all field technicians to execute the startup and functional checkouts and performance testing of the complete control system.
4. PLC and HMI developed program files shall become the property of the OWNER and shall be provided on USB drive with full access rights.

D. PLC & HMI Programming Software

1. The PLC and HMI programming software or approved equivalent are provided by the Contractor for Contractor use in developing the software applications for the project.

2.06 RADIOS & ANTENNAS

A. Antennas

1. The antenna and shall be selected with the Contractor's

determination of system gain required. Antenna shall be designed for frequency range of existing system. The antenna shall be capable of withstanding the environmental conditions of 125 mph winds and 0.5 inch radial ice without failure. Lighting protection shall comply with NFPA 780.

2. Antenna grounding conductors shall be minimum stranded, No. 6 AWG copper and connect into existing station grounding system.

B. Antenna Cables

1. Antenna cable shall have the following minimum specifications:
 - a. UV resistant polyethylene jacket rated for outdoor use.
 - b. 50 ohm impedance
 - c. Copper clad solid center conductor
 - d. Polyethylene dielectric insulation
 - e. 100% effective shielding
 - f. Outer conductor shall be copper braid or armor
 - g. -40 to 85 Deg C Operating Temperature
 - h. Required cable type/diameter shall be based on length of respective cable at each installation. Contractor shall determine cable length required. Contractor to provide calculation of cable insertion loss (IL) with specific cable make and model recommendations per location.
 - i. Times Microwave Systems or approved equivalent.
 - j. All antenna cables shall be of the same manufacturer. Contractor to provide all required cable kits, connectors, weather kits, boots, ground kits and all shall be for use with type and diameter of antenna cable provided

C. Antenna Cable Kits

1. Contractor to provide all required cable kits, connectors, weather kits, boots, ground kits and all shall be for use with type and diameter of existing antenna cables.

D. Radios

1. All radios shall be designed and configured to operate per FCC regulations and operate on a frequency required by the OWNER.
2. 24 Vdc powered, (1) 10/100 RJ45 Ethernet port, (1) RS232/485 RJ45 serial port, (1) mini USB 2.0 port.
3. Operating temperature -40 to 70 Deg C, 5 year standard manufacturer warranty, adjustable transmit power output, output impedance is 50 ohms, Antenna connection NB:TNC

3 PART 3 EXECUTION

3.01 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.

3.02 CHEMCP 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 Mounting

1. Floor standing enclosures shall be securely mounted to both the floor and wall/ structure. Floor fasteners and anchors shall be stainless steel.
2. All wall fastening shall utilize galvanized or zinc coated steel Unistrut, stainless steel fasteners and stainless steel anchors.

C. Enclosure Cutouts

1. All cutouts on 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 enclosures are not permitted.
3. All cutouts shall be free from burrs, rough edges and damage. Incorrect cutouts compromising the NEMA rating of the enclosure or impairing proper solid mounting of the respective component will require the Contractor to replace the door or enclosure.

D. 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.

E. 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.

F. 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.

G. Terminal Blocks

1. Terminal Block Installation
Terminal blocks shall be sized to accept wires terminating thereon. All terminal blocks shall be identified with wire number terminating thereon. All terminal blocks shall be of a color outlined in the products section. Terminal blocks shall be mounted on hi-rise mounting rail to permit easy installation and removal of wiring. Terminal blocks shall be provided with 15% spare terminals. Terminal blocks shall be furnished in cabinet

for all external connections. The side of terminals indicated for field connections shall be free of internal wire terminations. Provide end anchors at the end of a terminal section. Provide terminal block jumper bars / strips where common circuits are required on two or more terminal blocks.

2. Terminal Block Layout
Install and layout terminal blocks in common groups. Common groups are 120VAC, Neutral, Ground, 24VDC, Inputs, Outputs. Input and Output groups shall be installed in addressing order.

H. PLC Input/Outputs and Wiring

1. All PLC digital inputs shall be 24 VDC unless otherwise specified
2. Relay output cards shall be used to control AC voltage devices, systems with a different source of power, and where electrical isolation is required.
3. 24VDC outputs cards shall be used for 24VDC devices not exceeding 75 % of the power ratings of the output channel.
4. 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 appropriate colored terminal blocks. Input and output devices shall not be terminated directly on the PLC hardware terminals. Wiring to spare inputs and outputs shall bear the I/O number as the wire number. Direct wiring of panel components and field devices on the PLC cards is not permitted.

I. 120VAC Circuit Isolation and Protection

1. Separate 120VAC single pole circuit breakers are required to isolate and protect each of the following:
 - a) PLC power supply
 - b) HMI (if HMI is required)
 - c) 24VDC Power Supply
 - d) 120 VAC Instrument Field Power
 - e) Panel Receptacle
 - f) Panel Heater (when provided)
 - g) Air Conditioner or Fan (when provided)
 - h) PLC AC outputs (where 120VAC is used)
 - i) UPS Load Side Power
 - j) Communication/Interface Equipment

J. Power Circuit Isolation and Protection

1. Separate circuit isolation and protection is required for each of the following:
 - a) Control Panel Main – Fused or CB Disconnect with either a Lockable Front Door Mounted Rotary Operator or Lockable Flange Mounted Operator
 - b) Motor Starters – Circuit Breakers with Adjustable Trip
 - c) Variable Frequency Drives – Fuses as Specified by VFD Manufacturer
 - d) Control Transformer Primary - CB or Fuses (where required)

3.03 STATION RADIO ANTENNA AND KIT INSTALLATION

- A. Furnish and install radio antennas, antenna mast, ground kits, weather kits and surge protection. Installation shall be per the radio and antenna manufacturers' specifications and National Codes.
- B. All tubular radiator elements shall be plugged to prevent wind vibration fatigue. All vertical tubular elements shall have drain holes near the bottom. All outside connectors shall be snug, filled with silicone grease, and properly taped over with plastic tape suitable for cold weather.

1.01 CONTROL PANEL PLC PROGRAMMING

- A. The Contractor shall create each respective Control Panel PLC program to include but not limited to the following:
 1. Logic, data and descriptions not relevant or used (old code) shall be removed prior to FAT and/or SAT.
 2. Pump start/stop, sequence, interlocks, setpoints
 3. Primary and backup level qualification and switching (where required)
 4. Auto and Manual control
 5. All Alarm and Events and qualification
 6. Alarm interface with HMI and SCADA
 7. Setpoint and Control interface from HMI and SCADA
 8. Radio communications interface
 9. The program shall be written in a fault tolerant manner to prevent frequent operator intervention.

10. 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.
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.

1.02 CONTROL PANEL HMI PROGRAMMING

- A. The Contractor shall create each respective control panel HMI program as outlined herein. Screen graphics, details and layout shall take advantage of the screen size, resolution. Screens and functions shall be intuitive, text size easy to read, and easy intuitive navigation. Main overall pump and well screen graphic shall be the default home screen. Dark screen saver shall be used for periods or inactivity greater than 30 minutes.
- B. The Contractor shall accurately depict equipment and devices for the respective system. 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. HMI Animation Color
 13. Screen animation color shall be as follows unless otherwise indicated:
 14. Fault, Overload, or Alarm – Flashing Red
 15. Equipment or Device Running – Solid Green
 16. Equipment or Device Stopped – Solid Red
 17. Start Button – Solid Green
 18. Stop Button – Solid Red
 19. Valve Open - Solid Green
 20. Valve Closed – Solid Red

D. HMI Common Screen Features

1. Time and date
2. Screen name
3. Login/out button
4. Display the user name currently logged in
5. Station/Building name
6. Screen Menu Navigation "Tree"

E. HMI 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 status color is as follows:

Red and flashing – unacknowledged and in alarm

Red and not flashing – acknowledged and in alarm

Blue – unacknowledged, was in alarm but cleared

F. HMI Alarm List

1. The Contractor shall setup the HMI alarming to include but not limited to the alarm list(s) on the next page:

(CP-2) CHEMICAL BUILDING ALARM LIST	
Building Intrusion	
PLC Loss of Input Power	
Loss of Utility Power	
ATS on Generator	
Control Panel High Temperature	
Ortho Phosphate Chemical Pump - Faulted	
Chlorine Chemical Pump - Faulted	
Loss Communication to Reservoir	
Loss Communication to Pump Control Building PLC	
Loss Communication to Water Group	
Building Temperature - High High	
Building Temperature - High	
Building Temperature - Low	
Building Temperature - Low Low	
Building Temperature - Transmitter Failure	
Flow Meter #1 Flow Rate - High High	
Flow Meter #1 Flow Rate - High	
Flow Meter #1 Flow Rate - Low	
Flow Meter #1 Flow Rate - Low Low	
Flow Meter #1 - Transmitter Failure	
Ortho Analyzer - High High	
Ortho Analyzer - High	
Ortho Analyzer - Low	
Ortho Analyzer - Low Low	
Ortho Analyzer - Transmitter Failure	
Ph Analyzer - High High	
Ph Analyzer - High	
Ph Analyzer - Low	
Ph Analyzer - Low Low	
Ph Analyzer - Transmitter Failure	
Chlorine Analyzer - High High	
Chlorine Analyzer - High	
Chlorine Analyzer - Low	
Chlorine Analyzer - Low Low	
Chlorine Analyzer - Transmitter Failure	
Manganese Lift Station Pump #1 Overload	
Manganese Lift Station Pump #1 Failed to Start	
Manganese Lift Station Pump #1 Not in Auto	
Manganese Lift Station Pump #1 Motor Seal Failure	
Manganese Lift Station Pump #1 Motor Over Temperature	
Manganese Lift Station Pump #2 Overload	
Manganese Lift Station Pump #2 Failed to Start	
Manganese Lift Station Pump #2 Not in Auto	
Manganese Lift Station Pump #2 Motor Seal Failure	
Manganese Lift Station Pump #2 Motor Over Temperature	
Manganese Lift Station - High Level Float	

1.03 HMI SCREEN SECURITY

- A. HMI screens shall be setup with Admin access for setpoint changes and a View user access for viewing only and acknowledging alarms.
- B. Coordinate with OWNER on users names and passwords.

1.04 FAT TESTING

- A. The Contractor shall assemble and integrate the factory test setup as specified to prove the performance of the system satisfies all requirements, including system communication requirements in accordance with the approved test procedures. The FAT shall take place during regular daytime working hours on weekdays. Model numbers and software revisions shall be identical to those that will be delivered to site. The contractor shall execute the FAT test with OWNER/ENGINEER as witness. The FAT setup shall include the following:
 - 1. Completed and operational control panels with hardware and software as specified.
 - 2. PLC's communicating with HMI and radios as specified.
 - 3. HMIs and PLC's fully programmed as specified.
 - 4. Field devices and instruments shall be simulated utilizing wired toggle switches for digital inputs and 4-20mA sources for analog inputs to demonstrate field functions, program interlocks, sequences and HMI alarms.
 - 5. All control panel front door devices and equipment wired and operational
 - 6. Motor starters and VFDs operational
- B. The Contractor shall submit the FAT test document for review. The FAT shall not be scheduled until OWNER/ENGINEER have approved the FAT test document. Features and functions outlined below shall be outlined for execution in the FAT test document. At the conclusion of the FAT execution the Contractor shall make all revisions to the control system as noted in the FAT comments field. A scanned copy of the executed FAT test documents shall be provided to OWNER/ENGINEER at the conclusion of the test. The FAT test document shall include the following:
 - 1. PLC Hardware used.

2. PLC/HMI Software used.
 3. Description/List of Test and Simulation Equipment
 4. The FAT test execution section shall be created in Excel. Test "Procedure" step rows shall describe the required action per test followed by a "Results" row. The Results row shall have columns for "Initials", "PASS", "FAIL" and "Comments".
 5. The FAT test execution document shall include a list all PLC I/O address with respective columns for "I/O Description", "Initials", "PASS", "FAIL".
- C. All special testing materials and equipment required to demonstrate compliance with the specification shall be provided by the Contractor. Where it is not practical to test with real process variables, provide suitable means of simulation. These simulation techniques shall be subject to the approval of the OWNER/ENGINEER prior.

1.05 SAT EXECUTION

A. General

1. The SAT test procedures shall explain in detail, step-by-step actions and expected results to demonstrate compliance with the requirement of this specification. The Contractor shall deliver SAT test execution plans for the test prior to execution for review and approval of OWNER/ENGINEER.
1. All control system functions, alarms, sequences, inputs/outputs and operation possibilities shall be demonstrated. Where a function, sequence or operation cannot naturally occur at the time of testing, it shall be simulated.
2. Control set-points, modes of operation shall be modified through the HMI screen and other operator devices such as pushbuttons, selector switches, VFD controllers. Password protection shall be verified for all set-point entries and mode changes. The minimum and maximum set-point windows shall be tested for all analog levels.

B. TEST FAILURE ASSESSMENT

1. If the SAT 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. 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 test be fully 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.

C. CYBER SECURITY

1. A cyber security assessment may be required in 2026. Contact a cyber security firm such as Next Tier Cyber Security or equal
2. All SCADA and instrumentation equipment default passwords shall be changed upon installation and new passwords provided to the Owner.

END OF SECTION

**CONTRACT #2
SECTION 33 09 01**

INSTRUMENTATION FOR CONTROL SYSTEMS

PART 1 GENERAL

1.01 SUMMARY

This Section covers includes the general requirements for furnishing, installing, programming, adjusting, testing, documenting and commissioning of complete and operational SCADA and PLC based control systems. The control system includes the (1) one PLC control systems with Radio communications and related equipment for complete monitoring and control of the (1) one control buildings from the owners existing central SCADA system.

1. Chemical Control Building (CP-2)

1.02 RELATED SECTIONS:

1. Section 26 00 01 – Electrical Systems
2. Section 33 09 00 – PLC and SCADA Control Systems
3. Section 33 09 30 – Chlorine PH Measurement and Control Instrumentation
4. Section 33 21 40 – Chemical Metering Pumps

1.03 REFERENCES

- 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.

INSTRUMENT SOCIETY OF AMERICA (ISA)

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

1. NEMA 250 Enclosures for Electrical Equipment (1000 Volts Maximum)
2. NEMA ICS 1 Industrial Controls and Systems NEMA ICS 2 (1993)
Industrial Control Devices, Controllers and Assemblies

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

1. NFPA 70 National Electrical Code

UNDERWRITERS LABORATORIES (UL)

3. UL 50 Enclosures for Electrical Equipment
4. UL 83 Thermoplastic-Insulated Wires and Cables
5. UL 444 Standards for Communication Cables
6. UL 467 Grounding and Bonding Equipment

7. UL 698 Industrial Control Equipment for Use in Hazardous (Classified) Locations
8. UL 913 Intrinsically Safe Apparatus and Associated Apparatus for Use in Class I, II, and III, Division I Hazardous Locations
9. UL 1203 Explosion Proof and Dust Ignition Proof Electrical Equipment for Use in Hazardous Locations
10. UL 1449 Standard for Transient Voltage Surge Suppression
11. UL 1604 Electrical Equipment for Use in Hazardous Locations, Class I and Class II, Division 2 and Class III, Divisions 1 and 2

1.04 DEFINITION OF TERMS

- a) BOM – Bill of Materials
- b) CHEMCP – (CP-2) Chemical Control Building PLC System
- c) Contractor – PLC and SCADA control system integrator/contractor
- d) IFB – Issued For Bid
- e) IFC – Issued For Construction
- f) FAT – Factory Acceptance Test
- g) HMI – Human Machine Interface
- h) MFG – Manufacturer
- i) OEM – Original Equipment Manufacturer
- j) O&M – Operations and Maintenance
- k) PLC – Programmable Logic Controller
- l) PS – Pump Station
- m) SAT – Site Acceptance Test
- n) SCADA – Supervisory Control And Data Acquisition system
- o) SCP – Station Control Panel System
- p) VFD – Variable Frequency Drive

1.05 GENERAL

A Rules

The installation shall conform to the requirements of NFPA 70, unless more stringent requirements are indicated herein or shown.

B Coordination

The Contractor shall become familiar with all details of the work and verify all dimensions in the field so that the instrumentation shall be properly located and readily accessible. The instruments and enclosures shall be located to avoid interference with mechanical and structural features. The contractor shall coordinate the instrumentation installation and associated electrical work with architectural, mechanical, and electrical drawings and trades.

C Standard Products

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 five (5) years prior to bid opening. Like products shall be of the same manufacturer.

1.06 INSTRUMENTS

A Instrumentation Requirements

The contractor shall provide all instrumentation and quantities outlined on bid drawings and specifications. Refer to the respective Products section in this specification for the product selection criteria.

B Instrumentation and Device List

1. Chemical Building and Manganese Lift Station Instrumentation

- P-100 Manganese lift station – 2.6 HP submersible pump with temp / seal relay
- P-200 Manganese lift station – 2.6 HP submersible pump with temp / seal relay
- LS-50 Manganese lift station – Pump Off float
- LS-51 Manganese lift station – Pump On float
- LS-52 Manganese lift station – Pump lag Pump On float
- LS-53 Manganese lift station – High level float
- FT-50 Mag flow meter #1 (Badger Modmag M2000)
- AIT-50 Ortho analyzer
- AIT-51 PH analyzer
- AIT-52 Chlorine analyzer
- P-60 Ortho phosphate chemical pump
- P-61 Chlorine chemical pump
- TT-50 Chemical control building temperature transmitter
- ATS-2 Automatic transfer switch with status feedback
- XI-80 Door #1 Intrusion sensor
- XI-81 Door #2 Intrusion sensor
- XI-82 Door #3 Intrusion sensor
- XI-83 Door #4 Intrusion sensor
- LY-50 Outside building red status Light
- LCP-1 Vendor filtration system (Filter skid and control panel)

C Instrumentation Installation

The instrumentation installation location is outlined on the drawings. Coordinate with the mechanical contractor to determine the optimum location to facilitate the required feedback, and access for servicing. All instruments and related equipment shall be installed with manufacturer's recommended mounting hardware. All instruments shall be mechanically and electrically installed according to the manufacturer's installation recommendations.

D Instrumentation Ratings and Certificates

1. Hazardous Locations

Equipment installed in hazardous locations shall meet or exceed the Class, Group, and Division as outlined.

2. NEMA Rating

All instrumentation and related equipment, sensors, connectors, cables, and interfaces shall be rated for installation in outdoor wet use. They shall meet or exceed NEMA 4 as a minimum.

3. Environmental Rating

Where instruments, sensors, connectors, cables and interfaces shall be exposed to or in the presence of chemicals, they shall be intended and listed for use in that environment by the manufacturer. All electronics devices shall be rated to work at 5% to 95% humidity.

4. UL Rating

The label or listing of the Underwriters Laboratories, Inc., shall be accepted as evidence that the materials or equipment conform to the UL 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.

5. Calibration Certificate

All instruments shall be provided with the manufacturer's factory calibration sheet proving the equipment was calibrated to the standards and specifications as listed by the manufacturer.

2.01 SUBMITTALS

The following shall be submitted in accordance with SUBMITTAL PROCEDURES:

A Manufacturer's Data Sheets

Detailed manufacturers data sheets including primary element, sensor, transmitter, display, special cables, and mounting hardware. The data sheets shall be marked to indicate the specific model, model number, and options that are being proposed.

2.02 CLOSEOUT SUBMITTALS

A Manufacturer's Manuals

Provide the manufacture's product, setup, and troubleshooting manuals for all provided instrumentation. The contractor shall provide one (1) hard copy of the manufacturer's manuals.

B Instrument Configuration Manuals

Document and provide final instrumentation configuration for all instruments and sensors. The configuration data sheets shall be complete with all required setup information to facilitate reprogramming the instrument. The information shall include all required set-points, settings, and data to allow the instrument to be configured and put into service with the intended performance. The contractor shall provide one (1) hard copy and one (1) electronic copy on CD of the configuration data.

2.03 RESPONSIBILITIES

The contractor shall be responsible but not limited to the following:

- a) Instrumentation Selection
- b) Submittals
- c) Configuration and Interface
- d) Include in FAT Testing where possible
- e) Installation
- f) Startup
- g) Calibration
- h) SAT Testing
- i) Training
- j) Documentation

PART 2 PRODUCTS

2.01 GENERAL

- A Equipment 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.

- B All equipment shall be of industrial grade and shall be specifically intended for control, monitoring and environment. All equipment shall be of modular design to facilitate interchangeability of parts and to assure ease of servicing. Materials and equipment shall conform to the respective publications and other requirements specified below.
- C Similar items in the system shall be products from the same Manufacturer.

2.02 FLOW/LEVEL/PRESSURE INSTRUMENTS (WHERE OUTLINED OR REQUIRED)

A Magnetic Flow Meter

1. Magnetic flow meter systems shall include a magnetic flow tube and a microprocessor-based "smart" transmitter that is capable of converting and transmitting a signal from the flow tube. Magnetic flow meters shall utilize the characterized field principle of electromagnetic induction, and shall produce DC signals directly proportional to the liquid flow rate.
2. Each meter shall be furnished with a carbon steel metering tube and carbon steel flanges with a polyurethane, liner as required by the application and/or as specified herein. Liner shall have a minimum thickness of 0.125 inches. The inside diameter of the liner shall be within 0.125 inches of the inside diameter of the adjoining pipe. Liner protectors shall be provided on all flow tubes.
3. The flow tube shall be provided with flush mounted electrodes. Ultrasonic electrode cleaning shall not be acceptable.
4. Grounding rings shall be provided for all meters.
5. All materials of construction for metallic wetted parts (electrodes, grounding rings, etc.) shall be minimum 316 stainless steel, but shall be compatible with the process fluid for each meter in accordance with the recommendations of the manufacturer.
6. Flow tube shall be rated for pressures up to 1.1 times the flange rating of adjacent piping. System shall be rated for ambient temperatures of 30 to +65 Deg C. Meter and transmitter housings shall meet NEMA 4X requirements as a minimum. When meter and transmitter are located in classified explosion hazard areas, the meter and transmitter housings shall be selected with rating to meet the requirements for use in those areas. Non-metallic transmitter housings shall not be acceptable.
7. The transmitter shall provide pulsed DC coil drive current to the flow tube

and shall convert the returning signal to a linear, isolated 4-20 mA DC signal. The transmitter shall utilize "smart" electronics and shall contain automatic, continuous zero correction, signal processing routines for noise rejection, and an integral LCD readout capable of displaying flow rate and totalized flow. The transmitter shall continuously run self-diagnostic routines and report errors via English language messages.

8. Transmitter shall have a dual compartment housing with the terminal block isolated from the electronics compartment.
9. The transmitter's preamplifier input impedance shall be a minimum of 109-1011 ohms which shall make the system suited for the amplification of low-level input signals and capable of operation with a material build up on the electrodes.
10. Each flow tube shall be factory calibrated and assigned a calibration constant or factor to be entered into the associated transmitter as part of the meter configuration parameters. Manual calibration of the flow meter shall not be required. Meter configuration parameters shall be stored in non volatile memory in the transmitter. An output hold feature shall be provided to maintain a constant output during configuration changes.
11. The transmitter shall have built in diagnostics including high process noise detection, electronics temperature monitoring, wiring and grounding verification, coil fault detection and empty pipe detection. The transmitter shall also have the ability to enable internal calibration verification in the field. Calibration verification must not require external equipment.
12. Accuracy shall be 0.50% of rate over the flow velocity range of 0.3 to 10.0 m/s. Repeatability shall be 0.1% of rate; minimum turndown shall be 100:1. Minimum required liquid conductivity shall not be greater than 5 uS/cm. Maximum response time shall be adjustable between 1 and 100 seconds as a minimum. Transmitter ambient temperature operating limits shall be -10 to +50 Deg C. Power supply shall be 115 VAC, 60 Hz.
13. The transmitter shall be remotely mounted from the flow tube. The cables for interconnecting the meter and transmitter shall be furnished by the manufacturer.
14. Flow tubes shall be 150-lb flange mounted unless otherwise noted.
15. Badger Modmag M2000 or approved equivalent.

B In-Tank Submerged Pressure Transducer for Liquid Level

1. The transducer shall be rated for sludge and sewage wet well applications up to 100 feet. The unit shall be constructed of 316 stainless steel with a minimum of a 2 inch viton non fouling sensing diaphragm.
2. The electronics shall compensate for temperature variations from 32 Deg F to 120 Deg F. The output shall be a 2 wire 4-20mA loop powered output. The output range shall be factory preset and calibrated with a +/- 0.2 percent minimum accuracy. The cable shall be factory installed, minimum 20 gauge and rated for submergence and direct burial.
3. The unit shall not use breather tubes or other external means for compensation and correction.
4. Sigma Controls or Approved Equivalent

C Liquid Level Float

1. The float body shall be constructed of impact resistant PVC.
2. The float contacts shall be steel enclosed mercury type available in N.O or N.C. and rated for a minimum 10 amps at 120VAC.
3. The cable shall be a flexible SJOW water resistant neoprene. The conductors shall be a minimum of 16 gauge.
4. The float manufacturer shall have fastening and weight accessories to facilitate secure and repeatable operation.
5. Sigma Controls or Approved Equivalent

D Process Pressure Sensor and Transmitter (up to 150PSI)

1. The process isolation material shall be 316 stainless steel. The overpressure limit shall be a minimum of 750 psi with a minimum burst limit of 10,000 psi. The sensor shall be rated for -40.0 Deg F to 250 Deg F. The connection to the process shall be according to manufacturer's recommendations.
2. Transmitter shall be microprocessor based and shall convert the pressure sensor output to a scaled pressure range. The transmitter accuracy

shall be a minimum of +/- 0.065 percent of full span (0 to 150 psi) and a stability of +/- 0.125 percent over 5 years.

3. Transmitter shall be provided in NEMA 4X enclosure with LCD display scaled to read in engineering units with 2 wire loop powered 4-20 mA output. The unit shall be rated to operate at 0 to 100 percent humidity. The transmitter shall be rated for Class 1 Division 1 at temperatures of -50 Deg C to 60 Deg C.
4. Rosemount 3051 or Approved Equivalent

E Pressure Gauge

1. Type: Bourdon tube or bellows as required by pressure range. Phenolic case gauge with 4.5-inch dial. Dial shall have white face with black lettering. Provide unit with blowout protection. Provide glycerin filled gauges with ½-inch shut-off valve.
2. Fluid: Water at 120 degrees F (maximum).
3. Gauge Materials:
 - a. Lens: Acrylic.
 - b. Bourdon Tube and Socket: 316 stainless steel (bronze and brass if diaphragm seal is used).
 - c. Movement: Stainless steel.
4. Accuracy: $\pm 0.5\%$ (Grade 2A).
5. Gauge Connection Size/Location: 0.5 inch/lower.
6. Snubber: 316 stainless steel.
7. Diaphragm Seal: When called for, provide diaphragm seal with flushing connection and the following:
 - a. Type Seal: Welded diaphragm.
 - b. Upper Housing Material: 316 Stainless Steel.
 - c. Lower Housing and Wetted Parts Material: For water service, 316 stainless steel. For gaseous chlorine service, Hastelloy C, Monel or as otherwise recommended by the diaphragm seal manufacturer for gaseous chlorine service.
 - d. Upper Connection Size/Type: 0.5-inch NPT.
 - e. Lower Connection Size/Type: 1.0-inch NPT.
 - f. Diaphragm Material: For water service, 316 stainless steel. For gaseous chlorine service, diaphragm shall be Teflon, Viton, or as otherwise recommended by the diaphragm seal manufacturer for

gaseous chlorine service.

PART 3 EXECUTION

3.01 WIRING METHODS

- A Instrumentation Wire Separation
A.C. and D.C. wiring shall be kept separate as much as possible. All A.C. and D.C./Shielded instrumentation wiring shall be ran in separate conduits.
- B Wiring Identification
All instrument power and signal wiring shall be identified at both ends with wire numbers using heat shrinkable identification sleeves, or wrap adhesive type. All numbers and letters shall be done by a wire label printer. Hand written wire numbering will not be accepted.
- C Single Conductor Wire Color
Wire shall be color coded as follows:
 - A.C. line & load - Black
 - A.C. control - Red
 - D.C. power - Blue
 - D.C. common – White with Blue stripe
 - Neutral - White
 - Mechanical ground – Green or Green with Yellow stripe
- D Shielded Conductors
All shielded cable shall be stranded #18 AWG with a 100% coverage shield and drain wire, 150 volt insulation except where otherwise indicated. Terminate and ground shield and drain wire as indicated by manufacturers recommended wiring methods. All wiring shall be copper conductors.
- E Grounding
Instrumentation wire and shielded cable grounding practices shall follow the respective instrumentation manufacturer's recommendations. Grounding shall be in conformance with NFPA 70.

3.02 INSTRUMENTATION INSTALLATION

- A General
The instrumentation shall be installed mechanically and electrically according to the respective manufacturer. Additional installation requirements are outlined below.
- B Liquid Level Float

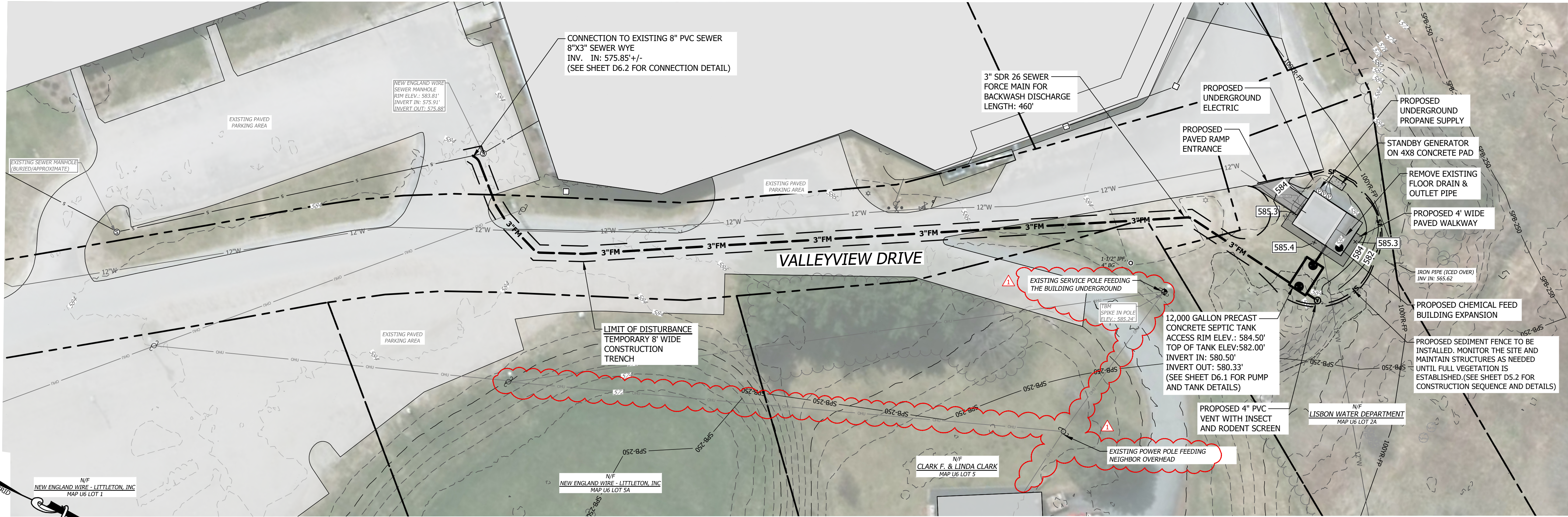
Install the floats such that the float does not interfere or come in contact with the other components throughout its range of motion in the well/tank. A compression fitting shall be installed where the cable enters a conduit.

- E In-Tank Submerged Pressure Transducer for Liquid Level
The transducer shall be suspended/installed 3 inches above the tank/well bottom and securely fastened to prevent movement and damage or interference to other components and transducer. A compression fitting shall be installed where the cable enters the conduit.

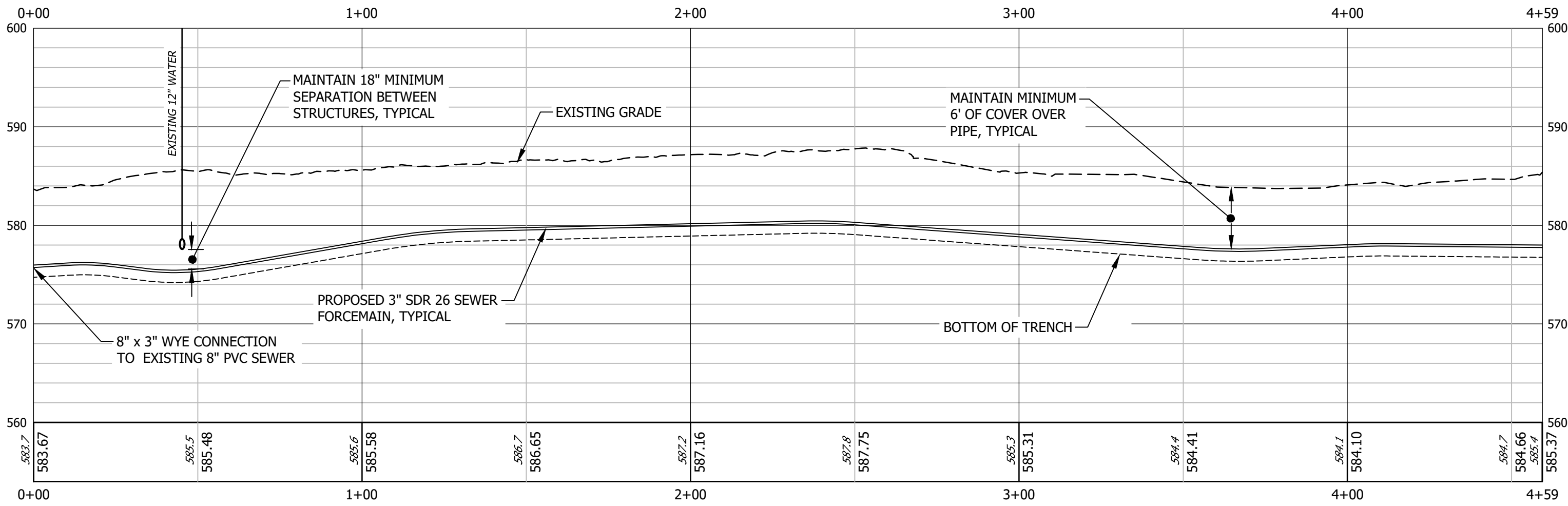
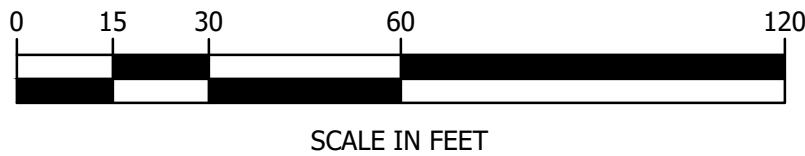
3.3 TRAINING

Provide a minimum of 8 hours of training on the Instrumentation setup, calibration, and maintenance after completion of all testing. Training time shall be coordinated with the owner and engineer.

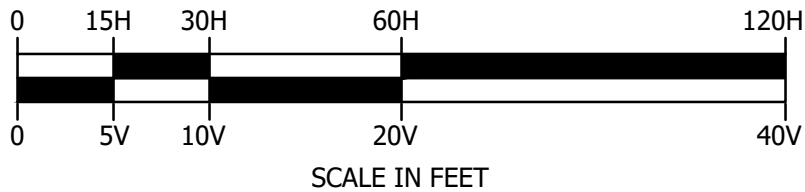
END OF SECTION



SEWER FORCE MAIN SITE PLAN
STA 0+00 TO STA 4+59.36



SEWER FORCE MAIN PROFILE
STA 5+50 TO STA 11+96.35

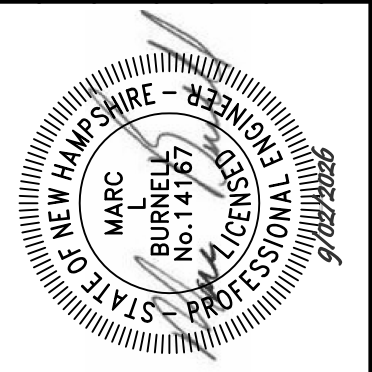


BIDDING PLANS
NOT FOR CONSTRUCTION

DATE OF PRINT
SEPTEMBER 02 2026
HORIZONS ENGINEERING

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PROJECT #:	21215	NO.	1	DATE	1 SEPT 2026	REVISION DESCRIPTION	ENG	DWG
DATE:	JULY 2026					ELECTRIC SERVICE INFORMATION	MLB	LJM
MAP-LOT (FOR ARCHIVE)	*							
SURVEYED BY:	HEI- D/G/NWS							
ENGINEERED BY:	MLB							
DRAWN BY:	LJM							
CHECKED BY:	CFC							



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SEWER FORCE MAIN STA 5+50 TO STA 11+96.35

SHEET C4.3

MOUNTING ABBREVIATIONS LEGEND:

SUBSCRIPT	
AT OUTLET	DESCRIPTION
OC	OVER COUNTER OUTLET: INSTALL BOTTOM OF OUTLET BOX 1-1/2" ABOVE HIGHEST ELEMENT OF COUNTER (I.E., BACKSPASH OR COUNTER TOP IF NO BACK SPLASH).
CR	CASEWORK RECESSED OUTLET: MOUNT BOX IN CASEWORK VERTICAL SURFACE.
EQ	EQUIPMENT OUTLET: FINAL TERMINATION METHOD AND EXACT LOCATION SHALL BE DETERMINED FROM EQUIPMENT MANUFACTURER'S APPROVED SHOP DRAWINGS.
AFF	ABOVE FINISHED FLOOR
AFG	ABOVE FINISHED GRADE
MTH	MOUNTING HEIGHT

RACEWAYS AND CONDUCTORS LEGEND:

SYMBOL	DESCRIPTION
	LOW VOLTAGE WIRING
	CIRCUIT IN CONDUIT RUN IN-SLAB OR UNDERGROUND
	CIRCUIT IN CONDUIT CONCEALED IN WALLS OR ABOVE CEILING WHERE POSSIBLE.
	HOMERUN TO PANELBOARD OR AS NOTED
	CONDUIT TURNING UP
	CONDUIT TURNING DOWN

RECEPTACLE OUTLETS LEGEND:

SYMBOL	NUMBER BY THE SIDE OF SYMBOL DENOTES CIRCUIT NUMBER. DEVICE MOUNTING HEIGHTS ARE DENOTED BELOW UNLESS OTHERWISE NOTED ON PLANS. COORDINATE EXACT LOCATIONS AND ALL MOUNTING HEIGHTS W/ ARCHITECTURAL PLANS/SECTIONS.
	DUPLEX CONVENIENCE OUTLET. MOUNT AT +18" AFF.
	DUPLEX CONVENIENCE OUTLET. MOUNT AT +18" AFF. 'X' DENOTES REUSE LOCATION.
	DOUBLE DUPLEX OUTLET (QUADPACLE RECEPTACLE). MOUNT AT +18" AFF.
	DUPLEX OUTLET. INSTALLED ABOVE CEILING AT LOCATION SHOWN.
	SINGLE DEDICATED OUTLET. MOUNT @ 18" AFF.
	SPECIAL OUTLET AS NOTED ON DRAWINGS. MOUNT AT +18" AFF. 'R' DENOTES RANGE. 'D' DENOTES DRYER.
	WIREMOLD 3000. DUPLEX RECEPTACLES SPACED 24" ON CENTER. WALL MOUNT AT 36" AFF.
 OR GFI	GROUND FAULT CIRCUIT INTERRUPTER
OC	OVER-COUNTER
WP	WEATHERPROOF

POWER APPURTANCES LEGEND:

SYMBOL	REFER TO PLANS FOR EXACT QUANTITIES AND LOCATIONS.
	FLUSH MOUNTED PANELBOARD AND CABINET. MOUNT AT 6'-6" MAX. AFF TO TOP.
	SURFACE MOUNTED PANELBOARD AND CABINET. MOUNT AT 6'-6" MAX. AFF TO TOP.
	ELECTRICAL PULL BOX, SIZED AS REQUIRED OR AS SHOWN ON DRAWINGS.
	JUNCTION BOX (JB) (IN ACCESSIBLE LOCATION).
	JUNCTION BOX (JB) (IN ACCESSIBLE LOCATION) W/ FLEXIBLE CONDUIT TO EQUIPMENT AS SHOWN. - JUNCTION BOX SUBSCRIPTS: 'C' CONTROL, 'D' DATA, 'DT' DATA/TELEPHONE, 'F' FIRE ALARM, 'P' POWER, 'T' TELEPHONE.
	MOTOR. HORSEPOWER AS SHOWN ON DRAWINGS.
	H.P. RATED MANUAL MOTOR STARTER (WEATHERPROOF WHERE OUTSIDE). SINGLE OR 2 POLE AS REQUIRED
	FUSED DISCONNECT SWITCH. SIZE AND FUSES PER MANUFACTURER'S RECOMMENDATIONS. WEATHERPROOF (WP) WHEN LOCATED OUTSIDE. 30A/3P MINIMUM.
	MOTOR CONTROLLER.

TYPICAL ELECTRIC HANDHOLE EQUAL TO QUARTZITE TYPE
'PG' 17"x30"x36" DEEP (OPEN BOTTOM) WITH
'ELECTRIC' ON COVER, INSTALLED FLUSH WITH GRADE

3500 PSI CONC. RING
AROUND HANDHOLE WHEN
IN SIDEWALK AREA

24" MIN. COVER

10"

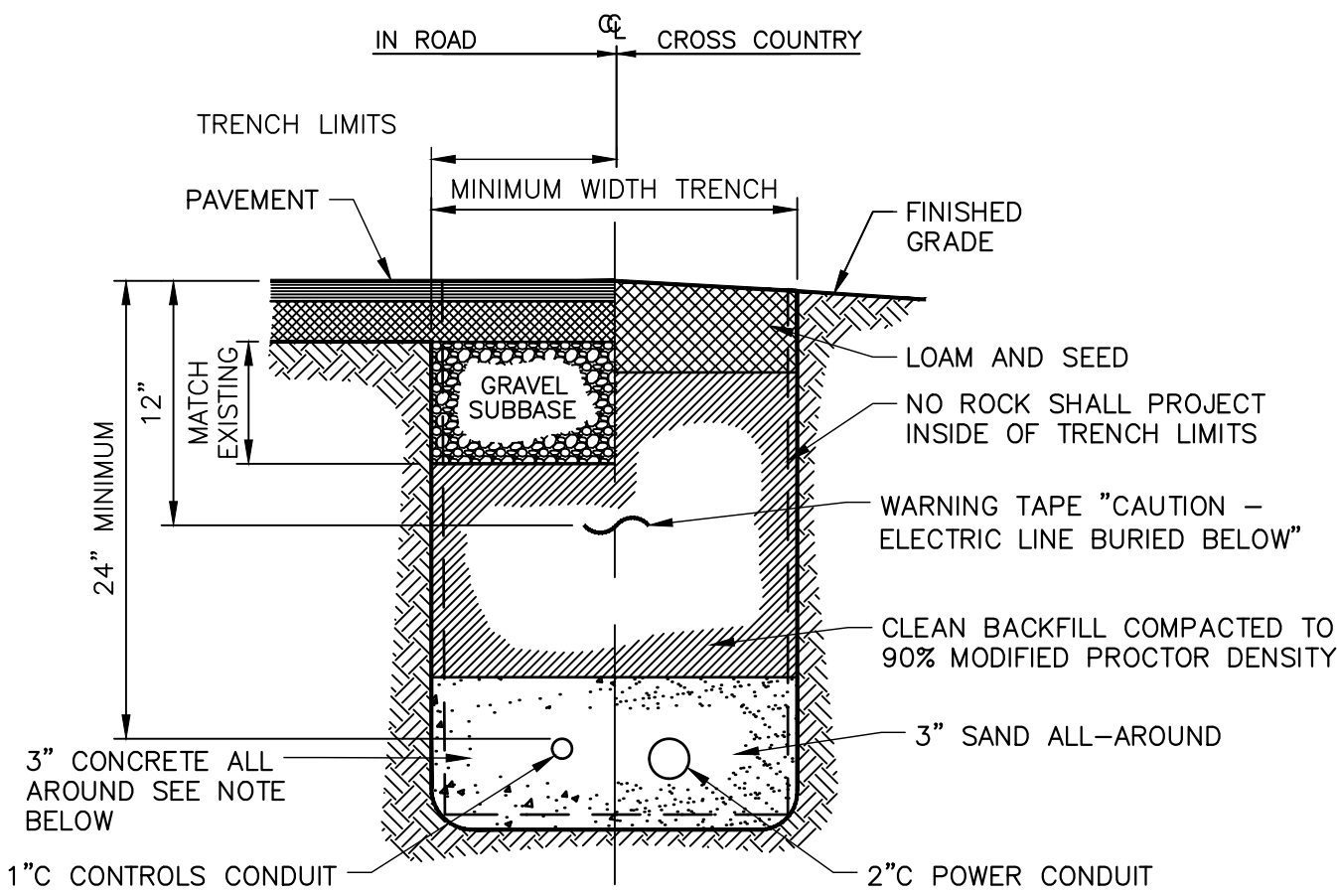
FINISH GRADE

6" CRUSHED
STONE BASE

COMPACTED TO
90% MODIFIED
PROCTOR DENSITY

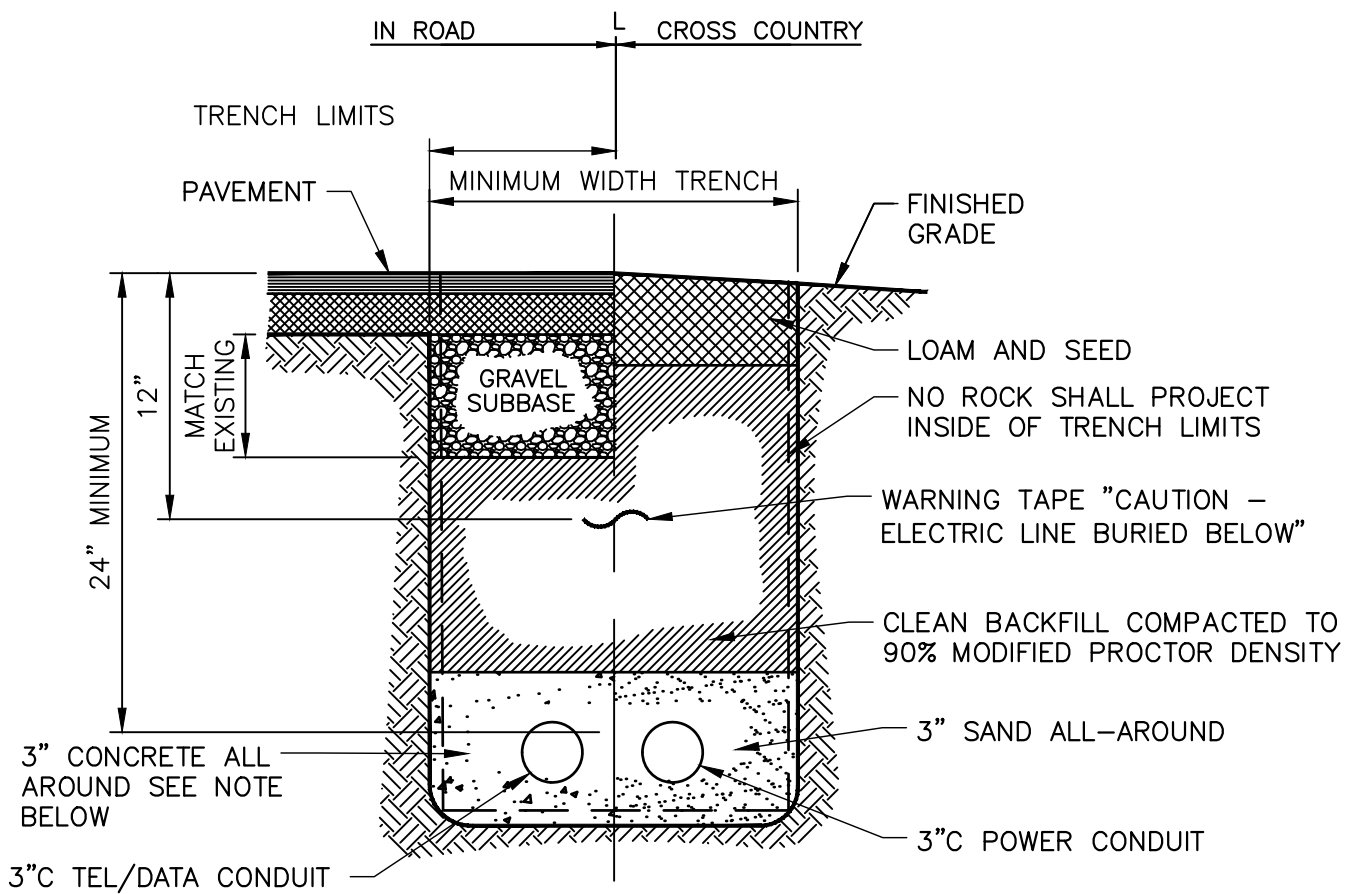
SLOPE TO BOX (TYP.)

NOT TO SCALE



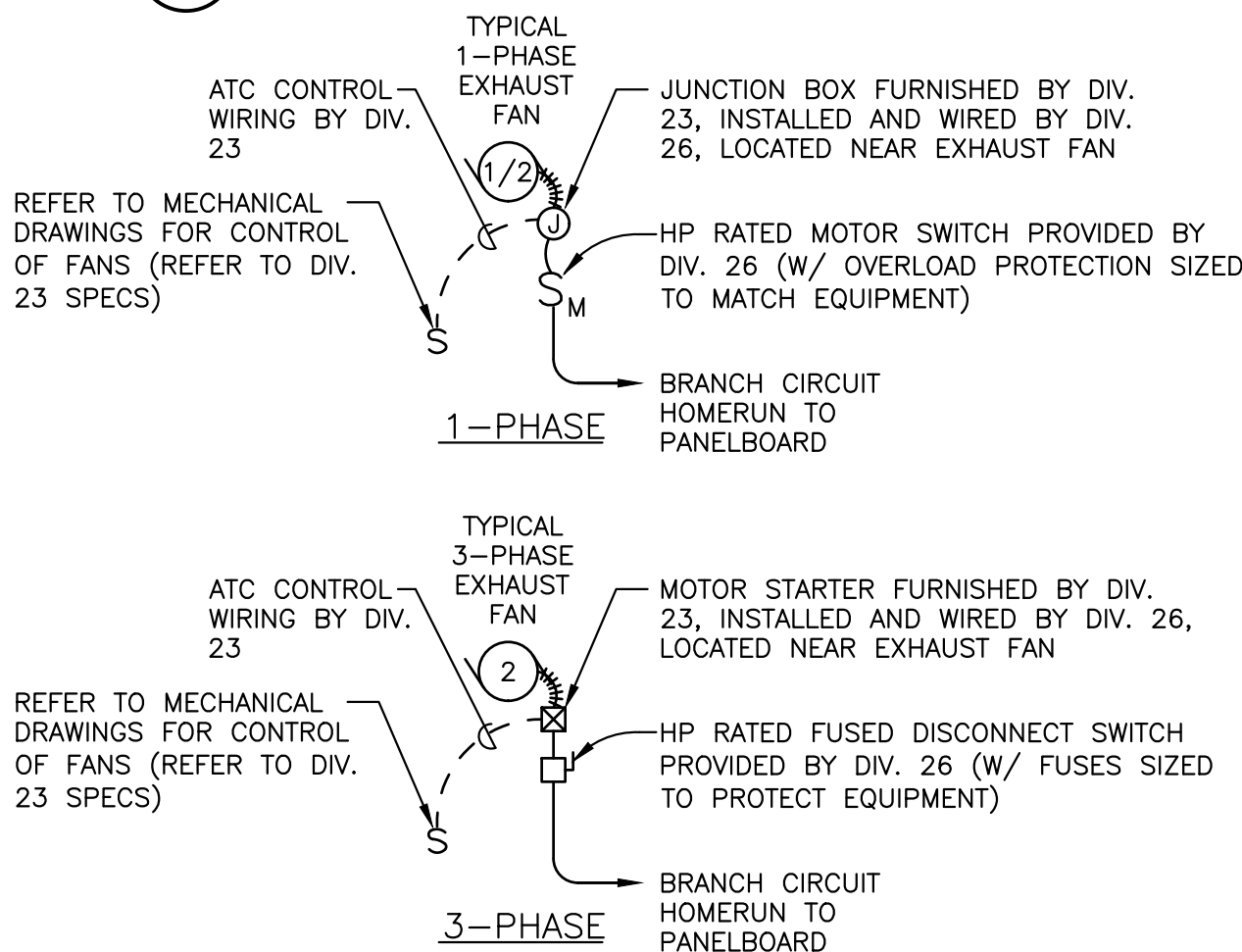
NOTES:
1. PROVIDE 3" CONCRETE ENCASEMENT AROUND PVC CONDUITS AT ALL ROAD AND DRIVEWAY CROSSINGS TO 5' BEYOND EDGE OF PAVEMENT. TYPICAL.

1 TYPICAL POWER AND CONTROLS TRENCH SECTION
E401 NOT TO SCALE



NOTES:
1. PROVIDE 3" CONCRETE ENCASEMENT AROUND PVC CONDUITS AT ALL ROAD AND DRIVEWAY CROSSINGS TO 5' BEYOND EDGE OF PAVEMENT. TYPICAL.

2 TYPICAL POWER TRENCH SECTION
E401 NOT TO SCALE

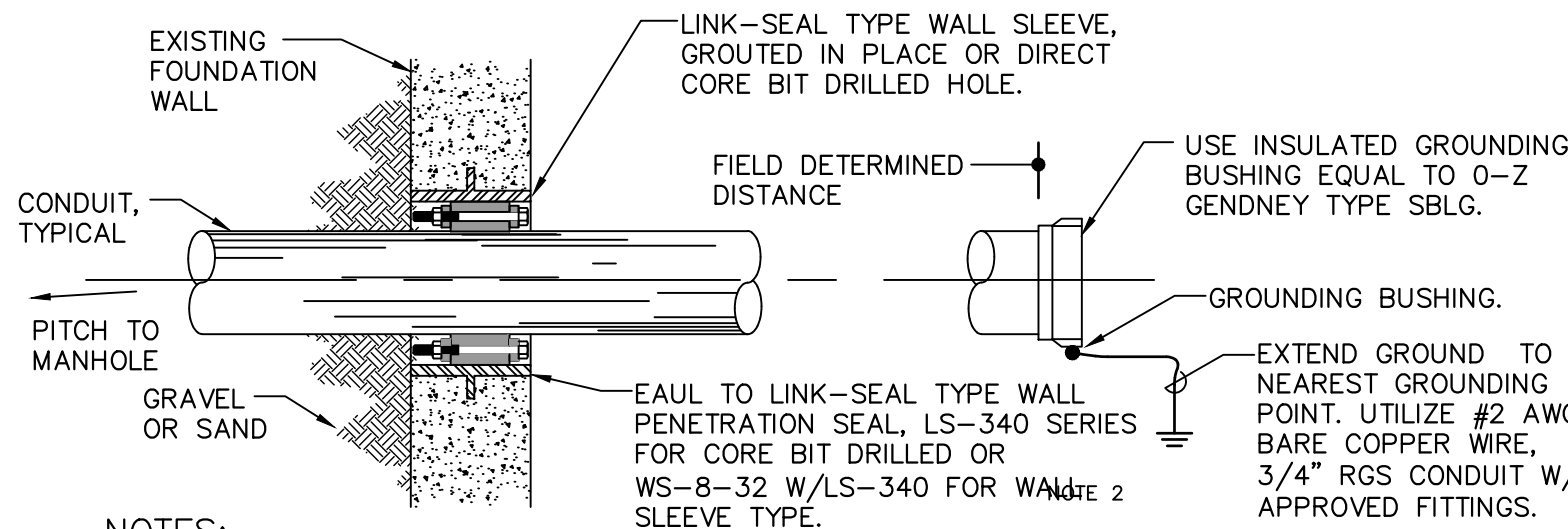


NOT TO SCALE

LIGHTING FIXTURE SCHEDULE

MARK	MANUFACTURER	CATALOG NUMBER	TYPE	COLOR	MOUNTING	VOLTAGE	LAMPS	REMARKS	TOTAL WATTS
A	LITHONIA LIGHTING	CSVTL48500LMMVOLT40K80CRI	6X48 IND.	WHITE	SURFACE	120	4946 LUMENS, 4000K		42
B	LITHONIA LIGHTING	WDGE2LEDP140K80CRIVFMVOLTDBXLPE	WALL PACK	BLACK	ABOVE DOOR	120	1200 LUMENS, 4000K	PROVIDE WITH PHOTOCCELL	12
EB	LITHONIA LIGHTING	EL2LM12	EMERGENCY	WHITE	WALL @8'	120			0.33

3. ALL ELECTRICAL WORK AND MATERIALS SHALL BE INSTALLED ACCORDING TO THE LATEST STATE ADOPTED NATIONAL ELECTRICAL CODE (NEC) AND ITS AMENDMENTS, NFPA AND ALL APPLICABLE FEDERAL, STATE AND LOCAL REGULATIONS.
2. THE ELECTRICAL CONTRACTOR SHALL OBTAIN AND PAY FOR ALL REQUIRED PERMITS AND INSPECTIONS.
3. ALL POWER WIRING SHALL BE IN CONDUIT OR MC CABLE (REFER TO SPECIFICATIONS). ALL RACEWAYS SHALL BE EMT (ELECTRICAL METALLIC TUBING) FOR INTERIOR AND PVC FOR UNDERGROUND. THE USE OF EXISTING CONCEALED CONDUITS FOUND TO BE IN GOOD ELECTRICAL CONDITION MAY BE USED. ALL CONDUCTORS SHALL BE COPPER GROUND (TYPICAL) WITH NUMBER OF CONDUCTORS AS REQUIRED. REFER TO PANEL SCHEDULES, TYPICAL. ALL CONDUCTORS SHALL BE COPPER, WIRE SIZE NO. 8 AWG AND SMALLER BE TYPE THHN/THWN INSULATION. SIZES LARGER THAN NO. 8 SHALL HAVE TYPE "THHN/THWN" INSULATION UNLESS OTHERWISE NOTES.
4. LIMIT 20A, 120V BRANCH CIRCUITS TO A MAXIMUM 1920VA LOAD AND 15A, 120V BRANCH CIRCUIT TO A MAXIMUM 1440VA LOAD.
5. ALL WIRING SHALL BE CONCEALED IN WALLS AND ABOVE CEILING IN FINISHED AREAS AND WHEREVER POSSIBLE. WIRING IN UTILITY AREAS (ELECTRICAL SPACE) MAY BE RUN EXPOSED AS APPROVED BY THE ARCHITECT. EXPOSED WIRING SHALL BE IN CONDUIT, BE PARALLEL TO BUILDING STRUCTURAL ELEMENTS AND PRESENT A NEAT AND COMPLETE INSTALLATION.
6. CONDUITS, RACEWAYS AND CABLES SHALL BE PROPERLY AND SECURELY ATTACHED TO BUILDING STRUCTURAL COMPONENTS AS REQUIRED BY NEC ALL FASTENERS AND HARDWARE SHALL BE APPROVED FOR THE INSTALLATION AND THE CONDITIONS ENCOUNTERED.
7. EACH OUTLET OR JUNCTION IN ANY OF THE WIRING SYSTEMS SHALL BE MADE IN AN APPROVED, METALLIC JUNCTION BOX. SUCH BOX SHALL BE SUITABLE FOR THE SIZE AND NUMBER OF CONDUCTORS AND DEVICES TO BE INSTALLED, AS WELL AS THE CONDITION ENCOUNTERED. ALL SPLICES SHALL BE MADE WITH APPROVED, ELECTRICAL CONNECTORS.
8. VERIFY ALL STRUCTURAL, ARCHITECTURAL AND ELECTRICAL CONDITIONS (DUCT CLEARANCES, COUNTER HEIGHTS, DOOR SWINGS, ETC.) PRIOR TO ROUGH IN FOR ELECTRICAL WIRING EQUIPMENT.
9. PRIOR TO ROUGH-IN OF ANY NEW PANEL BOARDS (IN NEW LOCATION) AND RECEPTACLES, THESE LOCATIONS AND MOUNTING HEIGHTS SHALL BE CLEARLY MARKED AND IDENTIFIED WITH SPRAY PAINT. ONCE COMPLETED, THE ARCHITECT/OWNER SHALL BE NOTIFIED THAT ALL LOCATIONS HAVE BEEN MARKED AND ARE READY FOR THEIR APPROVAL.
10. ALL ELECTRICAL WORK SHALL BE CAREFULLY COORDINATED WITH THE WORK OF OTHER TRADES AND ON-SITE CONDITIONS. WHERE CUTTING, DRILLING OR ALTERATION TO THE WORK OF OTHERS IS NECESSARY, FOR THE PROPER INSTALLATION OF ELECTRICAL EQUIPMENT, SUCH WORK SHALL BE PLANNED IN ADVANCE WITH THE GENERAL CONTRACTOR AND SHALL BE CAREFULLY DONE. ANY DAMAGE TO THE BUILDINGS OR EQUIPMENT SHALL BE REPAIRED BY PROPERLY TRAINED PERSONNEL, TO THE SATISFACTION OF THE ARCHITECT, AT NO ADDITIONAL COST TO THE OWNER.
11. DURING ROUGH IN AND FINISHED STAGES OF CONSTRUCTION, THE ELECTRICAL CONTRACTOR SHALL BE RESPONSIBLE TO PROTECT AND KEEP CLEAN ALL ELECTRICAL EQUIPMENT, PANELS, FIXTURES AND DEVICES.
12. THE CONTRACTOR SHALL PROVIDE ALL INFORMATION ABOUT EQUIPMENT WHICH IS BEING FURNISHED TO THE GENERAL CONTRACTOR FOR COORDINATION PURPOSES. THE CONTRACTOR SHALL PROVIDE ALL INSTALLATION DETAILS AND SUPPORT COMPONENTS TO THE GENERAL CONTRACTOR SO THAT THESE MAY BE BUILT INTO THE CONSTRUCTION IN A TIMELY MANNER.
13. THE CONTRACTOR SHALL BE RESPONSIBLE FOR VERIFICATION OF THE FINAL LOCATIONS OF ELECTRICAL, HVAC AND OWNER'S EQUIPMENT AND POWER CONNECTION DETAILS SO THAT THE ASSOCIATED ELECTRICAL WORK WILL BE PROPERLY COORDINATED AND INSTALLED.
14. WHERE WIRING CAN NOT BE ROUTED CONCEALED UTILIZE WIREMOLD SURFACE RACEWAY (SEE SPECIFICATIONS - WITH ALL NECESSARY FITTINGS/HARDWARE AND ATTACHMENT) WITH STRANDED TYPE TYPE THHN/THWN CONDUCTOR. ALL COMPONENTS SHALL BE PAINTED AS DIRECTED BY THE ARCHITECT. COORDINATE MOUNTING WITH ARCHITECT.
15. THE INTERIOR ELECTRICAL SYSTEM SHALL BE COMPLETELY AND EFFECTIVELY GROUNDING AS REQUIRED BY NEC. ALL METALLIC RACEWAYS SHALL BE ELECTRICALLY AND ELECTRICALLY SECURE AT ALL JOINTS AND AT ALL BOXES, CABINETS, FITTINGS, AND EQUIPMENT.
16. COMPLETE ALL PANEL BOARD CIRCUITS DIRECTORY CARDS TO REFLECT AS-BUILT CONDITIONS.
17. ALL RACEWAYS SHALL BE PROVIDED WITH EQUIPMENT GROUND CONDUCTOR. EQUIPMENT GROUNDING CONDUCTOR SHALL BE INSTALLED IN ALL ELECTRICAL RACEWAYS AND SHALL BE SPECIFIED IN ACCORDANCE WITH NEC 250-95 AND SHALL BE CONTINUOUS.
18. FURNISH, INSTALL, TEST, CALIBRATE, AND OTHERWISE MAKE OPERATIONAL ALL DEVICES AND EQUIPMENT SHOWN ON THESE DRAWINGS.
19. THE INTENT OF THESE DRAWINGS AND SPECIFICATIONS IS TO OBTAIN A COMPLETE AND SATISFACTORY INSTALLATION. AN ATTEMPT HAS BEEN MADE TO SEPARATE AND DEFINE THE CONTRACTOR'S WORK. THESE DRAWINGS ARE DIAGRAMMATIC, BUT SHALL BE FOLLOWED AS CLOSELY AS ACTUAL CONSTRUCTION OF THE FACILITY AND THE WORK OF OTHER TRADES WILL PERMIT. THESE DRAWINGS UTILIZE SYMBOLS AND SCHEMATIC DIAGRAMS TO INDICATE VARIOUS ITEMS OF WORK. THEREFORE, NO INTERPRETATION WILL BE MADE FROM THE LIMITATION OF SYMBOLS AND DIAGRAMS THAT ANY ELEMENTS NECESSARY FOR THE COMPLETE INSTALLATION ARE EXCLUDED. THE ARCHITECT SHOULD BE NOTIFIED OF ANY DISCREPANCIES, OMISSIONS, CONFLICTS, OR INTERFERENCE WHICH MAY OCCUR BETWEEN VARIOUS DRAWINGS AND SPECIFICATIONS. IF SUCH NOTIFICATION IS NOT RECEIVED, THE INSTALLING CONTRACTOR(S) SHALL BE RESPONSIBLE FOR THEIR INTERPRETATIONS.

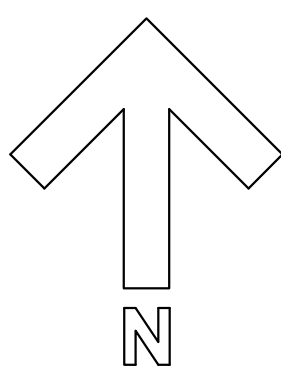


NOTES:

1. LINK-SEAL TYPE SEALING FITTING SHALL BE USED FOR ALL WALL PENETRATIONS. IF CORE BIT DRILLED SYSTEM IS USED AND CORE DRILL IS SMOOTH AND SUITABLE THE MODULE SEALING SYSTEM MAY BE USED. USE WALL SLEEVES IF ENTRY IS SIMILAR TO DETAIL 'CE'.
2. SLOPE DUCTS TOWARDS MH.
3. ALL CONDUIT PENETRATIONS SHALL BE PERPENDICULAR THROUGH FOUNDATION FOR PROPER SEAL.

NOT TO SCALE

I:\530379L Horizons Town of Lisbon Electrical Design Services for Chemical Feed and Control Building\Drawings\Electrical\Set-dwg 9/1/2026 8:18 AM



3/4" C TO LOCAL CONTROL
PANEL WITH SIGNAL WIRING
ORTHO ANALYZER (OA)
PP2-8 VIA WELL
PUMP STARTER CONTACT
3/4" C TO LOCAL CONTROL
PANEL WITH SIGNAL WIRING
PH ANALYZER (PA)
PP2-8 VIA WELL
PUMP STARTER CONTACT
3/4" C TO LOCAL CONTROL
PANEL WITH SIGNAL WIRING
CHLORINE ANALYZER (CA)
PP2-8 VIA WELL
PUMP STARTER CONTACT

CHEM PUMP POWER WIRING
CHEMICAL PUMP
CHEM PUMP SIGNAL WIRING
ELECTRIC UNIT HEATER

PROPOSED 50KW
PROPANE FIRED
GENERATOR ON PAD

GENERATOR
PAD

PROPANE TANKS

PROPANE

PROPANE

PROPANE

PP2-3 WP GFI

PP2-4

PP2-1

PP2-15

PP2-13

PP2-1

PP2-14

PP2-6

PP2-5,7

PP2-8

PP2-1

PP2-11

PP2-13

PP2-1

PP2-3

PP2-4

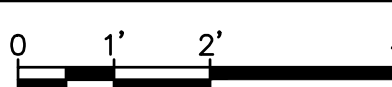
PP2-1

PP2-10,12

PP2-1

1 CHEMICAL FEED BUILDING POWER AND LIGHTING PLAN

SCALE: 1/2" = 1'-0"



BUS		200 Ampere										LOCATION		CHEMICAL FEED BUILDING																					
PANEL RATING		22 KAIC										MOUNTING		SURFACE																					
SUPPLY VOLTAGE		208Y/120V, 3Ø										DRAWING No.		E3																					
SERVICE		4-WIRE WITH GROUND BUS																																	
WIRING		VA OR W										BREAKER		VA OR W		DESCRIPTION		WIRING																	
WIRE		COND		DESCRIPTION		ØA		ØB		ØC		POLE		A		BUS		OCT		POLE		A		ØA		ØB		ØC		DESCRIPTION		COND		WIRE	
2#12, 1#12G		3/4"		INTERIOR RECEPT		720						1		20		1		2		1		20		546				INTERIOR LIGHTS		3/4"		2#12, 1#12G			
2#12, 1#12G		3/4"		EXTERIOR RECEPT				360				1		20		3		4		1		20				24		EXTERIOR LIGHTS		3/4"		2#12, 1#12G			
2#4, 1#10G		1-1/2"		ELECTRIC UNIT HEATER						5000		2		60		5		6		1		20				42		CHEM FEED PUMP (PM-1)		3/4"		2#12, 1#12G			
												7		1		5		8		1		20		300				INSTRUMENTS (CA, FM-1)		3/4"		2#12, 1#12G			
2#12, 1#12G		3/4"		EXHAUST FAN		5000		500				1		20		9		10		2		50		4500				BACKWASH PUMP CONTROLLER		1-1/2"		3#6, 1#10G			
2#12, 1#12G		3/4"		DEHUMIDIFIER				1200				1		20		11		12		1		50		4500											
2#12, 1#12G		3/4"		DESK POWER		720						1		20		13		14		1		20		1300				FILTER SYSTEM AIR COMPRESSOR		3/4"		2#12, 1#12G			
2#12, 1#12G		3/4"		FILTER EQUIPMENT POWER								1		20		15		16		1		20						SPARE							
				SPARE								1		20		17		18		1		20						SPARE							
				SPACE												19		20										SPACE							
				SPACE												21		22										SPACE							
				SPACE												23		24										SPACE							
TOTAL 1						6440		880		6200								TOTAL 2						2146		4524		4542							
TOTAL 2						2146		4524		4542																									
CONN. LOAD TOTAL						8586		5384		10742																									
AMPERES								69																											
SEE PROCESS DRAWINGS FOR CONTROL WIRING REQUIREMENTS.																																			
MAIN BREAKER															200A/3P																				
FEEDER ENTRANCE															BOTTOM																				
FEEDER SIZE															SEE ONE-LINE																				
SOURCE															UTILITY METER																				
PANEL TYPE															BOLT-ON																				
MAIN LUGS															N/A																				
ENCLOSURE TYPE															NEMA 3R																				
ACCESSORIES																																			
WITH HINGED COVER AND DOOR IN DOOR CONSTRUCTION																																			

SEE PROCESS DRAWINGS FOR CONTROL WIRING REQUIREMENTS.

PROVIDE GFI RECEPTACLE FOR CONNECTION OF
FILTER SYSTEM AIR COMPRESSOR. FINAL
RECEPTACLE LOCATION SHOULD BE COORDINATED
WITH FILTER SYSTEM INSTALLATION.

(2) 1" C WITH POWER FEEDS
TO PUMPS (1) 1" C WITH
FLOAT CONTROLS 24" B.F.G.

LOCAL CONTROL
PANEL (LCP-2)

VIA CONTROL
PANEL CP-2

UNDERGROUND TO
BACKWASH TANK PUMP

CONTROL PANEL (CP-2)

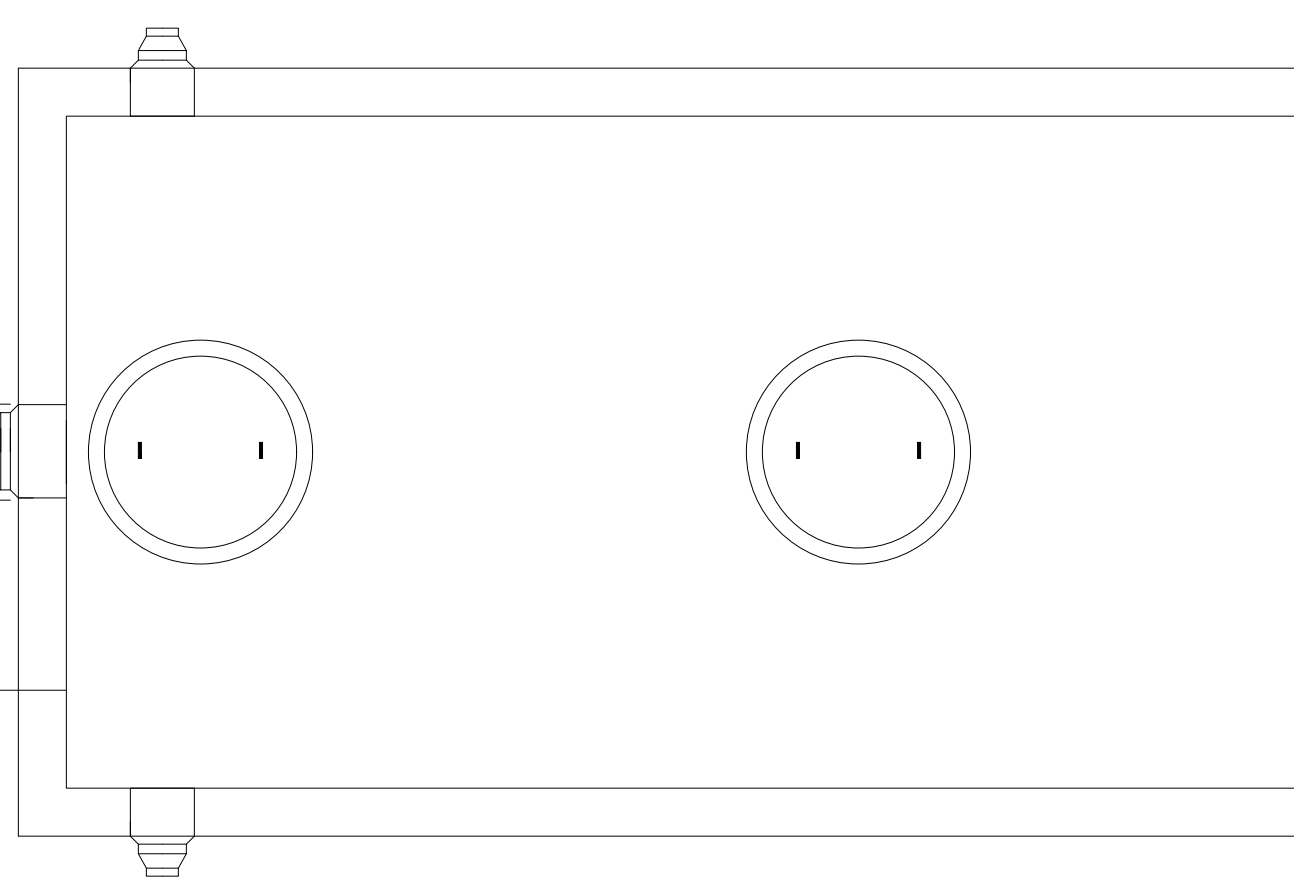
KEENE ROUGHLITE LED VWXL-14-NW-G1-8
WITH VGR100 RUBY GLASS GLOBE,
CONNECTION TO CONTROL PANEL COORDINATE
WITH CONTRACTOR FOR FINAL CONNECTIONS.

PANEL PP2

AUTOMATIC TRANSFER
SWITCH ATS-2

COORDINATION NOTE:

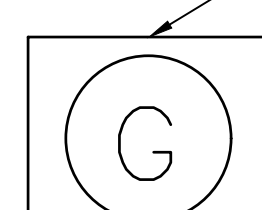
- COORDINATE FINAL CONDUIT AND FEEDER SIZES BASED ON
SELECTED CONTROLLER AND PUMP SELECTION.
- BACKWASH TANK PUMP IS BASED ON 240V/1P 2 HP PUMP
SELECTION IN CIVIL DRAWINGS. CONFIRM WITH CONTRACTOR
FINAL APPROVED PUMP PACKAGE AND CONTROLS PRIOR TO
ROUGH IN. FINAL CONTROL AND PUMP POWER
REQUIREMENTS MAY DIFFER FROM DESIGN.
- COORDINATE WITH MECHANICAL CONTRACTOR TO AVOID ANY
WATER LINES WITHIN THE ELECTRICAL EQUIPMENT WORKING
SPACES PER ARTICLE 110.26.



ELECTRIC SERVICE:
208Y/120V 3Ø, 4W
NOMINAL 200A

PROVIDE NEW 200A/3P METER
AND BREAKER

50KW 208V/3P GENSET



4#4/0,
1#6G CU,
2-1/2" C

200A AUTOMATIC
TRANSFER SWITCH

PANEL PP
208/120V
3PH, 4W
200A MCB
22 KAIC

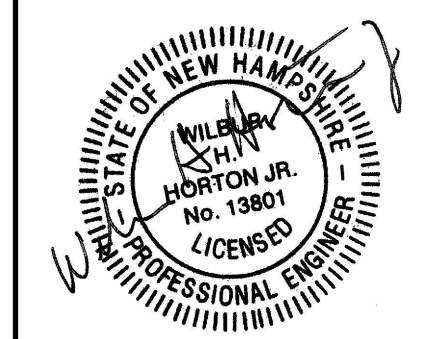
SURGE
PROTECTIVE
DEVICE

CHEM FEED BLDG ONE-LINE DIAGRAM

NO SCALE

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REVISIONS	BY	EJD	DATE	REVISION DESCRIPTION
1			08/25/2026	ELECTRICAL CHANGES TO CONTROL BUILDING

CLIENT NAME
TOWN OF LISBON
46 SCHOOL STREET
LISBON, NH 03585
(603) 838-6376

PROJECT NAME
WATER SYSTEM
IMPROVEMENTS
PROJECT

PROJECT ADDRESS
BISHOP ROAD &
VALLEYVIEW DRIVE
LISBON, NH

SHEET TITLE
ELECTRICAL
SITE
POWER
PLAN
AND
DETAILS

D&K PROJECT # 530379 PROJ. ENG. CFA

DRAWN BY EJD CHECKED BY WHH

DATE SEPTEMBER 2026

SHEET NUMBER

E2P

SHEET: 27 of XX