

**SECTION 16010
ELECTRICAL GENERAL REQUIREMENTS**

PART 1 - GENERAL

1.01 DESCRIPTION

A. Work Included:

1. All items of labor, materials and equipment, not specified in detail or shown on drawings but necessary for complete installation and proper operation of work described or implied, shall be furnished and installed.
2. Test all electrical conductors, after completion of installation of wiring and apparatus, to ensure continuity, proper splicing, freedom from grounds, except "made grounds" and those required for protection and insulation resistance. Use testing instruments, i.e. megger. Activation of each circuit will be required as final test. Testing shall be done at no additional expense to the Owner.
3. Drawings are indicative of work to be installed but do not indicate all bends, fittings, boxes, etc. that will be required in this Contract. The structural and finished conditions of the project shall be investigated prior to construction.
4. Coordinate work with other trades to avoid interference between piping, ducts, equipment, architectural or structural features. In case of interference, the Engineer decides which work is to be relocated, regardless of which is first installed.
5. Visit the site to determine actual conditions. No extra compensation will be allowed by failure to determine existing conditions.

B. Additional Circuits:

1. A sum of money shall be included in the Base Bid for the Contract for five (5) additional circuits. Each additional circuit shall include the following:
 - a. 100' of 3/4" rigid aluminum conduit, and associated fasteners and connectors.
 - b. 300' of #14 THHN/THWN wire, or 100' of 1 PR. #18 shielded cable.
 - c. (1) PVC coated cast outlet box/pull box/junction box
 - d. 6' of 3/4" flexible, liquid-tight conduit

- e. Final connections to motor, receptacle, lighting control switch, instrument, control or power wiring circuit
2. The additional circuits shall be included in the Contractor's schedule of Values.

1.02 QUALITY ASSURANCE

A. Regulations, Standards and Publications:

ANSI	American National Standards Institute, Inc.
ASTM	American Society for Testing and Materials
IEEE	Institute of Electrical and Electronic Engineers
IPCEA	Insulated Power Cable Engineers Association
NEC	National Electrical Code of National Fire Protection Association
NEMA	National Electrical Manufacturers Association
NESC	National Electrical Safety Code
UL	Underwriters' Laboratories

1. The installation must comply with all Federal and State, municipal or other authority's laws, rules and/or regulations.
2. Inspections by the required authorities shall be made. Original final wiring certificates with two copies shall be submitted to the Owner.
3. The electrical inspections shall be made by the Middle Department Inspection Agency, or other inspection agency approved by the Owner.
4. All electrical equipment and its components and materials shall meet all applicable UL criteria and bear the appropriate label of the Underwriters' Laboratory.
5. All electrical equipment or apparatus of any one system shall be of the same quality as produced by one or more manufacturers, suitable for use in a unified system. The term "manufacturer" shall be understood as applying to a reputable firm who assumes full responsibility for its products.

1.03 SUBMITTALS

A. General:

1. Submit in accordance with Section 01300.

B. Shop Drawings:

1. All shop drawings shall be submitted to the Engineer for review. All shop drawing submittals shall clearly indicate, using arrows and/or highlighting on all copies, which item(s) are being submitted and that each item being submitted is in compliance with all requirements on the drawings and in

these specifications. All pertinent specification and drawing requirements shall be indicated on the shop drawings. If incorrect, they shall be resubmitted in quantity according to Contract conditions until satisfactory. Work shown on shop drawings shall not be executed until such drawings are approved. Electrical items shall not be installed until final approval of the shop drawings has been given by the Engineer.

2. See specific sections for a breakdown of shop drawing items.
3. Submit certification that all equipment is UL listed.
4. Shop drawings shall indicate adequate clearance for operation, maintenance and replacement of operating equipment devices.
5. The Engineer reserves the right to request additional shop drawings.

C. Installation, Operation and Maintenance Manuals:

1. Submit required number of installation, operation and maintenance manuals for all equipment being provided for the electrical system. These manuals shall be submitted in electronic pdf format and in 3-ring loose-leaf binders. The manuals shall be complete, neat, orderly and indexed.
2. The installation, operation and maintenance manuals shall include a copy of the approved shop drawings for all electrical items installed on the project.

1.04 PRODUCT DELIVERY, HANDLING AND STORAGE

A. Product Handling:

1. Deliver all materials in good condition. Store in dry place, off ground, and keep dry at all times.

B. Protection of Installation:

1. All unfinished installations, construction materials and equipment shall be protected during construction.

PART 2 - PRODUCTS

2.01 SEE SPECIFIC SECTIONS FOR PRODUCTS

PART 3 - EXECUTION

3.01 INSTALLATION

A. Protection of Installation:

1. All equipment shall be protected during construction. All damaged equipment caused by noncompliance with this requirement shall be repaired at no expense to the Owner.

B. Openings and Chases:

1. Determine locations of chases and openings prior to construction so that same may be provided where required. If openings or chases are made after building construction is accomplished, such cutting and repairing of the building shall be made by this Contractor in complete coordination with other trades on the job site to match original conditions in quality, color and type of materials used, and at no additional expense to the Owner.

C. Position of Outlets and Equipment:

1. The Engineer shall determine the position of all relocated outlets and equipment if the required location differs from that indicated on the drawings.

D. Moving Outlets Equipment:

1. The Owner reserves the right to move any outlets, equipment enclosure, a distance of ten feet before roughing in, at no additional expense.

E. Methods and Materials:

1. All work shall be installed in a first-class, neat and workmanlike manner by skilled mechanics. All materials shall be new. Firmly support all materials and equipment.

F. Cutting, Repairing and Finishing:

1. All cutting, repairing, finishing and painting required for the installation of work under this Contract shall be performed under this Contract.
2. All disturbed surfaces shall be repaired and finished to match adjacent surfaces by skilled mechanics working in their respective fields.

G. Excavation and Backfilling:

1. Excavation and backfilling shall be in accordance with the requirement of Division 2 and as required to complete the work according to details on drawings.

- H. Concrete:
1. Concrete work shall be in accordance with the requirements of Division 3 and as required to complete the work according to details on drawings.
- I. Cutting and Patching of Concrete Areas:
1. Openings in concrete required for Electrical construction shall be made by taking extreme precautions to prevent excessive damage to existing facilities. Prior to completion, all disturbed areas shall be closed, restored to normal and finished to match surrounding areas.
- J. Access:
1. Install all conduit, wire, cable, wiring devices and equipment to preserve access to all equipment installed under this Contract.
- K. Layout of Wiring:
1. The layout of wiring as shown on the drawings shall not be considered as absolute. It shall be subject to changes where necessary to overcome obstacles in construction. Where a major deviation from the plans is indicated by practical consideration, shop drawings shall be submitted showing all deviations in detail to clearly indicate the necessity or desirability for the change.
- L. Miscellaneous Supports:
1. Furnish and install all necessary angles, beams, channels, hanger rods or other supports for equipment and piping furnished under this Contract requiring support or suspension from building structure. All supports shall be 316 stainless steel.
- M. Clean Up:
1. Upon completion of all work under the electrical specifications, furnish labor, materials and incidentals to accomplish the following: remove all dirt, foreign materials, stains, fingerprints, etc. from all lighting fixtures, glassware, panelboards, wall plates, system equipment, floors, walls and ceilings adjacent to the above equipment and leave the electrical work in such a condition that no cleaning will be required by the Owner. The complete system shall be subject to inspection and approval by the Owner.

END OF SECTION 16010

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**SECTION 16050
BASIC MATERIALS AND METHODS**

PART 1 - GENERAL

1.01 DESCRIPTION

A. Work Included:

1. All items of labor, materials, and equipment necessary for complete installation and proper operation of work described or implied, shall be furnished and installed.

1.02 QUALITY ASSURANCE

A. Regulations, Standards and Publications:

ANSI	American National Standards Institute, Inc.
ASTM	American Society for Testing and Materials
BOCA	Building Officials and Code Administrators
IEEE	Institute of Electrical and Electronic Engineers
IPCEA	Insulated Power Cable Engineers Association
NEC	National Electrical Code of National Fire Protection Association
NEMA	National Electrical Manufacturers Association
NESC	National Electrical Safety Code
UL	Underwriters' Laboratories

B. Qualification of Manufacturers:

1. Various materials specified herein shall be as supplied by manufacturers listed under PRODUCTS.

C. Quality Control:

1. All equipment shall be new and limited to products regularly produced and recommended for service ratings in accordance with engineering data or other comprehensive literature made available and in effect at time of bidding. In all cases where device, or devices, or part of equipment is herein referred to in singular, reference shall apply to as many items as required to complete installation.

1.03 SUBMITTALS

A. Shop Drawings:

1. Submit in accordance with General Requirements. Shop drawings shall be complete in all respects and shall indicate all dimensions, installation

methods, size, weight, capacity, ratings, integral controls and types of materials, elevations, and sections.

2. All shop drawing submittals shall clearly indicate, using arrows and/or highlighting on all copies, which item(s) are being submitted and that each item being submitted is in compliance with all requirements on the drawings and in these specifications. All pertinent specification and drawing requirements shall be indicated on the manufacturer's drawings.
3. Submit manufacturer's latest publications for the following items:
 - a. Conduit and Fittings
 - b. Wire
 - c. Instrumentation Cable
 - d. Outlet Boxes
 - e. Junction Boxes
 - f. Pull Boxes
 - g. Convenience Receptacles
 - h. Local Control Switches
 - i. Panelboard
 - j. Manual Starter Switches
 - k. Disconnect Switches
 - l. Uni-Strut
 - m. Conduit Link Seals
 - n. Conduit Labels

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Conduit:
 1. PVC conduit shall be Schedule 40, suitable for installation underground in a concrete duct bank.
 2. Rigid steel conduit shall be mild steel piping, zinc coated, and of sufficient weight and toughness to withstand cracking and peeling during bending. Galvanizing to be a coating of zinc of uniform thickness applied by either electrolytic or hot metal dip process.
 3. Rigid aluminum conduit shall be 6063-T1 aluminum alloy and shall comply with Federal Specification WW-C-540C.
 4. Each piece of rigid conduit to be straight, free from blisters and defects, cut square and taper reamed, finished in 10' lengths and threaded at each end. Couplings shall be supplied at one end and a protective sleeve for the other end. All threads shall be clearly cut. Each length of conduit shall bear Underwriters' Label.

5. PVC coated galvanized rigid steel conduit shall have a permanent plastic coating factory applied to a minimum thickness of 40 mils and a urethane internal coating. PVC coated conduit shall be Plasti-Bond Red H₂O_T as manufactured by Robroy Industries, Ocal Blue as manufactured by the Occidental Coating Company, or Perma-Cote Supreme as manufactured by Perma-Cote Industries.
 6. Flexible nonmetallic conduit shall conform to Articles 350 and 351 of the NEC and shall be UL listed. All flexible nonmetallic conduit shall have nonmetallic screw-in type connectors and couplings. All flexible conduit shall be liquid-tight type.
 7. Minimum size of rigid conduit shall be 3/4". Minimum size of flexible conduit shall be 1/2".
- B. Wire:
1. Wire shall be type THHN/THWN, except for underground wiring, which shall be type XHHW. All wiring shall be stranded, copper with 600 volt insulation. Aluminum wire will not be acceptable.
 2. Wire shall be 90°C, suitable for wet or dry locations.
- C. Instrumentation Cable:
1. Instrumentation cable for analog signal wiring shall be #18 AWG twisted shielded pairs with tinned copper conductors, 300 volt polyethylene insulation, a continuous foil shield with 100% coverage, and a tinned copper drain wire.
 2. The instrumentation cable shall be Beldon #8760, or equal.
- D. Conduit Fittings:
1. Conduit fittings for steel conduit shall be made of rust resisting alloy of iron or steel. An iron fitting shall be cast malleable iron thoroughly coated with metallic zinc or cadmium inside and outside after all machine work is completed.
 2. Conduit fittings for aluminum conduit shall be made of aluminum.
 3. Conduit fittings for PVC conduit shall be PVC.
 4. Each conduit fitting shall be provided with heavy threaded hubs to fit the conduit used. A cast fitting shall be used on all exposed conduit runs except at impractical locations where factory ells may be used.
 5. All conduit fittings used for PVC coated conduit shall be PVC coated and shall be Form 8 with encapsulated screws.

6. All fittings in wet locations shall be gasketed.
- E. Outlet Boxes:
1. Each outlet box shall be sized in accordance with current editions of all Federal, State and local codes.
 2. All outlet boxes shall have mounting lugs or ears for mounting wiring devices and covers. Each outlet box shall be equipped with an appropriate cover.
 3. Outlet boxes shall be cast type of same construction as cast fittings described above.
- F. Junction Boxes:
1. Junction boxes shall be cast type, and shall be of same construction as cast fittings, unless noted otherwise on the Drawings.
 2. Junction boxes identified on the Drawings as NEMA 4X aluminum shall be constructed of Type 5052 H-32 aluminum, and shall have gasketed shoe box type covers with stainless steel screws.
 3. Label all junction boxes with an engraved nameplate fastened to the junction box. Nameplate shall be black with 1/4" white lettering.
- G. Pull Boxes:
1. Pull boxes identified on the Drawings as NEMA 4X aluminum shall be constructed of Type 5052 H-32 aluminum and shall have gasketed shoe box type covers with stainless steel screws.
 2. Pull boxes identified on the Drawings as fiberglass shall be Hoffman, or equal.
 3. Label all pull boxes with an engraved nameplate fastened to the pull box. Nameplate shall be black with 1/4" white lettering.
- H. Panelboard:
1. Panelboard shall be dead front automatic circuit breaker type suitable for connection to the system characteristics and with circuit breakers as called for on the panel schedules. Circuit breakers shall be thermal-magnetic type with quick-make, quick-break operating mechanism and with trip indication. Trip indication shall be clearly indicated by breaker handle taking a position between "ON" and "OFF". All 2-pole breakers shall be common trip. Breakers shall be plug-in type. Breakers used as switches shall be rated for that purpose.

2. Bus bars and lugs shall be plated copper. The ampere rating of the main bus bars and lugs on each panelboard schedule shall be considered a minimum. Larger ampere rating main bus bars and lugs may be required to accommodate the number of poles indicated on the panelboard schedules or to accommodate large wire sizes.
 3. Panelboard box shall be made of code gauge galvanized steel, factory assembled as a complete unit and large enough to provide ample wiring space.
 4. Panelboard front shall be complete with door and flush chrome plated pin type cylinder lock and catch. All panelboards shall be keyed alike. Front shall have adjustable indicating trim clamps which are completely concealed when the door is closed. Door shall be mounted with completely concealed hinges.
 5. Panelboard shall have a minimum interrupting capacity as indicated on the Drawings, and boxes with a minimum width of 20".
 6. Panel shall be factory prime coated, and finish coated with baked acrylic enamel. Label all panelboards with an engraved nameplate fastened to the front of the panel. Nameplate shall be black with 1/4" white lettering.
 7. Panelboard shall be furnished with a surge protective device (SPD) where indicated on the Drawings. The SPD shall have a minimum 160kA rating.
 8. Panelboard shall be installed in a NEMA 4X stainless steel enclosure.
 9. Panelboard shall be Square D or Eaton.
- I. 15 Ampere, 120 Volt, Single Receptacles, NEMA 5-15R:
1. Single receptacles shall be corrosion resistant, 20 ampere, 3 wire, U-ground to meet Federal Specification WC-596. Receptacle color shall be yellow.
 2. Single receptacles shall be Arrow Hart #5361-CR, Hubbell #53CM61, Leviton #5361-CR, or equal.
- J. 20 Ampere, 120 Volt, Duplex Receptacles, NEMA 5-20R:
1. Duplex receptacles shall be 3 wire, U-ground, to meet Federal Specification WC-596. Receptacle color shall be ivory.
 2. Receptacles shall be Arrow Hart #5362, Bryant #5362, Hubbell #5362, Leviton #5362, Pass & Seymour #5362, or equal.

- K. 20 Ampere, 120 Volt, Duplex Receptacles, NEMA 5-20R (G.F.I. Type):
1. All receptacles noted, as G.F.I. receptacles shall be 20 Amp ground fault circuit interrupter receptacles. Receptacles shall be the "Standard" End-of-Line" type, which protects itself only. "Feed-Thru" installation will not be permitted. Devices shall be Class A, UL listed.
 2. Provide a weatherproof cover for G.F.I. receptacles where indicated on the Drawings. Cover shall be self-closing and UL listed.
- L. Switches:
1. Local control switches, other than those mounted on a panelboard, shall be 20 ampere, 120-277 volt, AC, meeting Federal Specification WS-896E. Switch color shall be ivory.
 2. Switches shall be single pole, double pole, three-way, four-way or type as noted. Switches shall be Arrow Hart #1221, Bryant #4901, Hubbell #1221, Leviton #1221, Pass & Seymour #20AC, or equal.
- M. Wall Plates:
1. Local control switches, receptacles and similar wiring devices shall be provided with stainless steel wall plates with beveled edges. Plates shall be same manufacturer as wiring device used.
 2. At locations where FS condulets are used for switches or receptacle outlets, an FS condulet plate shall be used. Plates shall have beveled or rounded edges and shall fit flush with all sides of the FS condulet.
- N. Manual Starter Switches:
1. Manual starter switches shall consist of a single pole snap switch and a thermal overload device. Size of overload element shall be based on the nameplate rating of the motor it is to protect. Switches shall be furnished with a red pilot light and an H/O/A switch. Switches shall be mounted in an outlet box where wiring is concealed and in a condulet box where wiring is exposed.
 2. Manual starter switches shall be rated for 1 hp at 120V AC and shall be manufactured by Square D or Allen-Bradley.
- O. Disconnect Switches:
1. Disconnect switches shall be non-fusible, size and NEMA enclosure as indicated on the Drawings, quick-make, quick-break, heavy-duty. Provide a ground lug in each disconnect switch.
 2. NEMA 4X disconnect switches shall be 316 stainless steel.

3. Label all disconnect switches with an engraved nameplate fastened to the disconnect switch.
 4. Disconnect switches shall be Square D or Eaton.
- P. Uni-strut:
1. Uni-strut shall be used where indicated on the drawings to support conduit and electrical equipment. Uni-strut shall be stainless steel or fiberglass, as indicated on the Drawings.
 2. Stainless steel uni-strut shall be 316 stainless steel.
 3. Fiberglass uni-strut shall be manufactured by Enduro, or equal.
- Q. Conduit Link Seals:
1. Conduit link seals shall be installed in all core-drilled holes for sealing around the conduit. All link seal bolts shall be stainless steel.
- R. Conduit Labels:
1. Conduit labels shall be PVC sleeves that wrap around conduit. Labels shall indicate the voltage of the wiring inside the conduit.
- S. Fire Resistant Foam Sealant:
1. All penetrations through floors and walls shall be sealed with Nelson Firestop Products CLK, Cat. #AA492, silicon based sealant, or equal.
 2. All wall or floor penetration openings shall be as small as possible.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Conduit:
1. All direct buried conduit shall be PVC coated galvanized rigid steel, unless noted otherwise on Drawings.
 2. All conduits in concrete duct banks shall be PVC Schedule 40.
 3. All conduits embedded in concrete slabs shall be PVC. Where conduits turn up out of the slab, they shall be PVC coated galvanized rigid steel.
 4. All buried conduit for motor feeders from VFDs shall be PVC coated galvanized rigid steel.

5. All exterior exposed conduit shall be rigid aluminum.
6. All exposed conduit in the Clarifier Building, shall be rigid aluminum.
7. All wiring shall be run in conduit.
8. Install conduit so wires may be removed and replaced at a later date.
9. Short runs of flexible nonmetallic conduit with separate ground wire shall be used for connection of motors and instrumentation. Approximately 18" runs of flexible nonmetallic conduit shall be used for connection of all HVAC equipment. No rigid connection to HVAC equipment will be permitted.
10. Running threads will not be permitted. Use an approved threaded coupling or a suitable union where required. Setscrew couplings will not be permitted.
11. Space supports for conduit not more than 5' apart. Support conduit by one-hole malleable iron pipe straps or beam clamps. Where it is impractical to use beam clamps and where conduit is installed on building surfaces, use back straps and approved fastening devices with malleable iron pipe straps. All straps and clamps for PVC coated conduit shall be permanently PVC coated by same manufacturer as conduit.
12. Where it is necessary to cross building expansion joints, provide conduit runs with suitable expansion fittings.
13. Provide conduit expansion fittings in aluminum conduit at 30'-0" intervals.
14. No horizontal runs of conduit will be permitted in masonry walls.
15. All conduit penetrations into electrical equipment enclosures shall be made using conduit hubs. PVC coated rigid steel conduit systems shall use PVC coated conduit hubs.
16. Bend conduit only by use of an approved pipe bending machine or hickey so the conduit will always retain its cylindrical shape. PVC coated conduit shall be bent and threaded only with tools manufactured for that purpose.
17. If the PVC coating on conduit and fittings is damaged during installation, the damaged conduit or fitting shall be replaced in its entirety by the contractor. Repairing damaged conduit with touch-up paint will not be acceptable.
18. Install metallic electrical warning tape above all underground duct banks and conduit. Tape shall be 6" wide with red background and black letters. Letters shall read "CAUTION ELECTRICAL LINE BURIED BELOW". Install tape 6" below finished grade.
19. Label all exposed conduits at each end of the conduit run.

B. Outlet Boxes:

1. An outlet box shall be furnished and installed at each outlet, firmly in place, and set true and square.
2. All outlet boxes shall be supported from the building structure, independent of the entering conduit. All unused knockouts must remain closed.

C. Wiring:

1. The voltage drop at the end of any circuit shall not exceed 3% of the normal line voltage under full load. No wires smaller than #12 AWG shall be used for branch circuits; pilot and control circuits shall not be smaller than #14 AWG.
2. Care shall be exercised in pulling wire into conduit so as not to injure insulation. Use pulling compound as required.
3. Conductors to be continuous from outlet to outlet. Splice only within outlet or junction boxes.
4. Balance circuits across the phase wires of the branch and distribution panels. Run separate neutral wires for all circuits.
5. Switches shall not be connected to the neutral conductor.
6. Power and control wiring shall be run in separate conduits. AC and DC circuits shall be run in separate conduits.
7. All wiring shall conform to the following color code:

240 Volt, 3 Phase:	Black, Red, Blue - Phase Wires White - Neutral Wire
240 Volt, 1 Phase:	Black, Red - Phase Wires
120 Volt, 1 Phase:	Black - Phase Wire White - Neutral Wire
Control Wires:	120V AC - Red 24V dc – Blue
Ground Wires:	Green
8. AC control wires energized from a source external to the control panel power source shall be yellow.
9. All control wiring shall be identified at each end with a legible permanent coded wire-marking sleeve. Sleeves shall be heat-shrink white PVC tubing with machine printed black marking, as manufactured by Brady Markings

shall be in accordance with the wire numbers and terminal numbers shown on the control panel wiring diagrams.

- D. Splices:
1. Make all splices using solderless connectors. Use wire nut connectors composed of expandable spring steel shell and PVC insulator for size #14 through #8. Temperature rating shall be 105°C. For size #6 and larger, use bolted-type tinned copper pressure connectors, either the straight coupling type or the split bolt type.
 2. All connectors #6 and larger shall be wrapped with UL approved liner-less rubber splicing tape rated to 69 KV and vinyl plastic electrical tape to the same thickness as the insulation of the wire. Electrical tape shall be Scotch 33+, or equal.
- E. Lugs:
1. All lugs used with copper wire and cable shall be tinned copper. Aluminum will not be accepted.
- F. Panels:
1. Furnish a typed list identifying all circuits and insert in frames provided inside of panel doors.
- G. Mounting Heights:
1. Mounting heights and exact locations of all equipment to be verified by the Owner before roughing in.
 2. Unless otherwise instructed, outlets shall be located as follows:
 - a. Local Lighting Control Switches: Locate all outlets for single or gang switches 3'-4" above finished floor on strike side of door. If this location places the switch group partly in tile or other finishes, the outlet shall be lowered or raised to place the plate entirely on a flat surface.
 - b. Duplex Receptacles: 36" above finished floor, unless noted otherwise on the Drawings.
 - c. Panelboard: 6'-0" above finished floor to top of panel.
 - d. Disconnect Switches: 4'-6" above finished floor to top of switch, unless noted otherwise on the Drawings.

END OF SECTION 16050

**SECTION 16060
GROUNDING SYSTEM**

PART 1 - GENERAL

1.01 DESCRIPTION

A. Work Included:

1. Furnish all labor and materials required to complete all work necessary for an electric service and branch distribution grounding system. System shall include but not be limited to all grounding electrodes, ring conductors, connectors, and miscellaneous accessories such as bonding lugs, bushings and jumpers in accordance with the current edition of the National Electrical Code and as specified herein.
2. In addition to grounding/bonding connections required to comply with NEC provisions, a grounding ring system shall be installed as indicated herein or on the Drawings. This system is intended to provide bonding between all process and structural components and the electrical distribution system grounding. The description "process piping" where included herein shall be understood to mean all metallic piping systems where they occur on the site. Other process and structural components shall be grounded as specifically described herein to provide a complete system with all metallic components at the site bonded together.

1.02 QUALITY ASSURANCE

A. Regulations, Standards and Publications:

ANSI	American National Standards Institute, Inc.
ASTM	American Society for Testing and Materials
IEEE	Institute of Electrical and Electronic Engineers
NEC	National Electrical Code of National Fire Protection Association
UL	Underwriters' Laboratories

1.03 SUBMITTALS

A. Shop Drawings:

1. Shop drawings shall be complete in all respects and shall indicate all dimensions, installation methods, size, weight, capacity, ratings and types of materials.
2. All shop drawing submittals shall clearly indicate, using arrows and/or highlighting on all copies, which item(s) are being submitted and that each item being submitted complies with all requirements on the Drawings and in these Specifications. All pertinent Specification and Drawing

requirements shall be indicated on the manufacturer's drawings. Submit shop drawings on the following:

- a. Grounding Electrodes
- b. Grounding Conductors
- c. Grounding Conductor Connectors
- d. Conduit Grounding Bushings
- e. Conduit Grounding Jumpers
- f. Exothermic Weld Process and Components
- g. Grounding System Resistance Test Equipment
- h. Grounding System Test Point Sleeves

B. Literature:

1. Submit manufacturer's latest publications for each item.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Grounding Electrodes:

1. Grounding electrodes shall be 10'-0" long, 3/4" diameter copper clad steel. Exterior shall be electrolytic copper metallicity bonded to a round one-piece carbon steel rod. The electrodes shall be fabricated so as to prevent mushrooming of rod head during driving, or a steel-driving stud, manufactured for such a purpose, shall be used.
2. Electrodes shall conform to the requirements of UL Specification No. 467 (ANSI C-33.8-1972).
3. Electrodes shall be Blackburn, Carolina or equal.

B. Ground Conductors:

1. Electric service ground conductor shall be sized in accordance with NEC Article 250-66 and shall be connected to the associated building/structure grounding ring as well as all other equipment and building components required by the NEC.
2. The grounding rings shall be annealed temper, stranded, bare, copper, uncoated type. Individual members of stranded conductor shall meet the requirements of ASTM B3, and the overall fabrication shall meet the requirements of ASTM B8 for stranded conductors.
3. Size of grounding ring conductors shall be #4/0 AWG.
4. All connections between the grounding ring and the individual equipment or building/structure components called for to be grounded herein shall be

made using #2/0 AWG copper cable of the same type as the grounding rings.

- C. Grounding Jumpers:
1. UL listed jumpers shall be provided on all metallic conduit expansion fittings whether or not the circuit is provided with a separate ground conductor. Jumpers shall be braided, tinned copper, factory connected as a single assembly to two galvanized steel U-bolts. OZ Gedney Type "BJ" (for steel conduit), or equal.
- D. Grounding Bus:
1. All power distribution equipment, motor control centers, panelboards, load centers, terminal boxes, transformers, etc. shall be furnished with a factory installed grounding bus or termination point.
- E. Electrical Conduit Grounding Bushings:
1. Conduit connectors shall be insulated bushing type for grounding and bonding. Fitting shall have ground lug terminal as well as a bonding setscrew in the circumference of the bushing. Appleton "G1B" series, OZ Gedney "BLG" series, Steel City "BG" series or equal.
- F. Exothermic Weld Connections:
1. All underground grounding system connections shall be exothermically welded, including all cable connections to grounding electrodes (rods), concrete reinforcing and any other utilities required to be grounded but are not accessible from above grade.
 2. The welding process shall use a mixture of copper oxide and aluminum packaged according to connection type in plastic tubes. The packages shall be nonexplosive and shall not be subject to spontaneous ignition.
 3. All welding materials used shall be Cadweld as manufactured by Erico Products, Inc. or equal and shall meet or exceed the requirements of IEEE Standards 80 and 837 and as listed in MIL 419.
- G. Exposed Mechanical Type Grounding System Connectors:
1. The following equipment, structural and nonstructural components at the site shall be connected with a #2/0 AWG, soft-drawn, stranded, tinned copper, bare grounding conductor with the described materials or fitting to the associated building or structure grounding ring. (These items are in addition to the electrical distribution grounding requirements described elsewhere herein.) In addition to the component and fitting manufacturers listed herein and on the Standard Details, fittings and components manufactured by Burndy, OZ Gedney, Dossert or Teledyne/Penn-Union will also be accepted:

- a. Concrete slab reinforcing steel
 - b. Panelboard
 - c. DAF Control Panel
2. Components used for grounding conductor connections shall be as indicated herein or on the Drawings.
- H. Grounding Conductor Connection Lugs:
1. Grounding conductor connection lugs shall be aluminum for all connections to aluminum materials. Grounding conductor connection lugs for connections to all other materials shall be copper. All aluminum-to-copper connections shall be made according to the lug manufacturer's recommendations using an appropriate cleaning and oxidation prevention compound, Penetrox A-13 or equal.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. General:
1. Grounding system shall comply with the current edition of the National Electrical Code, the current edition of the National Electrical Safety Code and as specified herein.
 2. Flexible conduit to motors shall not be used as a ground conductor.
 3. All ground conductors shall be copper and sized according to the requirements of the NEC, Table 250-66 and Table 250-122 as applicable.
 4. All conduits shall be furnished with a separate ground conductor. Conduits shall not be used as a ground conductor.
 5. All metallic electrical conduits shall be bonded to the equipment ground terminal, ground wire or ground bus using an insulated ground bushing and jumpers sized as required by the NEC. Bond shall be provided at all conduit terminations.
 6. Flexible jumpers (bonding straps) shall be installed where conduit expansion fittings occur.
 7. Ground conductors shall be green, insulated stranded type where installed in conduit.
 8. Grounding ring and all associated conductors shall be soft drawn, stranded copper, size 4/0, bare type.

9. Unless otherwise indicated on the drawings or in the specifications, all copper-to-copper or copper-to-steel splices and terminations for ground ring and connections to the ground ring shall be made by controlled exothermic reaction welding process, using the appropriate fittings for the process employed. Steel shall be ground or filed, and copper conductors shall be cleaned, to ensure all surfaces are clean, dry and free from oxide before welding process is performed.
10. System ground ring and top of ground electrodes shall be direct buried to a minimum depth of 24" and a maximum depth of 30". Electrodes shall be driven straight down, perpendicular to the finished grade.
11. Ground electrodes in the ground ring shall be installed at no less than 10' intervals nor greater than 20' intervals.
12. The term "grounding ring" shall be understood to mean a copper conductor, as specified of this Section, buried and connected to grounding electrodes (driven rods) at + 15'-0" intervals, to completely encircle the associated building or structure. Splices in and connections to the copper conductor and grounding electrodes shall be made using an exothermic weld process, as described of this Section.
13. All metallic water piping systems shall be connected to the building's associated ground ring at two locations. Where flow meters, valves, flexible piping or any type of nonmetallic connection occur in a piping system, a bonding jumper shall be installed around the device to ensure ground continuity. Jumpers installed under other portions of these specifications, such as reference grounds for process flow meters, etc., shall not be used to replace or be considered as grounding system jumpers.
14. Rebar in concrete structures shall be connected to the grounding ring at two locations for each structure.
15. The ground ring shall be furnished with test points as indicated on the drawings. The test points shall consist of a 6" diameter, Schedule 40 PVC conduit brought flush with finished grade and extending down to 4" below point on ground rod where ring conductor is attached. The PVC shall be notched as required to prevent stress on the ground ring conductor if the PVC conduit is pushed downward from grade for any reason. Provide threaded end cap on top of PVC conduit. End cap shall be labeled "GROUND TEST POINT".
16. Testing of actual ground resistance shall be made by the Contractor before any finish landscaping is accomplished. Testing shall not be performed until after all underground connections are made and buried and after all structural steel has been connected to the ground ring. Test shall be made at the ground ring using a megger type ground tester and the "fall of potential" test method. Maximum resistance at the test point shall be 5 ohms unless otherwise noted. Where measured values exceed the above figures, the Contractor shall install additional electrodes at no additional

cost to the Owner until further tests indicate the ground resistance has been reduced to the specified limit.

END OF SECTION 16060

**SECTION 16210
ELECTRIC SERVICE**

PART 1 - GENERAL

1.01 DESCRIPTION

A. Work Included:

1. Furnish all labor and materials to install a complete new electric service to the Clarifier Building including conduit, wiring, termination, metering, and all equipment and labor required, as shown on Drawings, and specified herein.
2. Service characteristics for the new electric service are 120/240 volt, 1 phase, 3 wire. Power company is Potomac Edison.
3. The address for the Clarifier Building is 8100 Hampton Valley Road, Emmitsburg, MD 21727.
4. All power company coordination is the responsibility of the Contractor.

1.02 QUALITY ASSURANCE

- A. Contact power company for specific instructions regarding service requirements before beginning work. Complete system must meet with power company approval, and shall meet all power company requirements
- B. Power company contact is Garrett Hixon. Phone number is 301-271-5907.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Electric Service Conduits for New Service:

1. Electric service conduits for the new service shall be PVC Schedule 40, encased in a concrete duct bank for straight runs of conduit. At bends, the conduit shall be PVC coated galvanized rigid steel.

PART 3 - EXECUTION

3.01 INSTALLATION OF NEW ELECTRIC SERVICE

A. Electric Service Conduits:

1. Electric service conduits shall start at the electric service pole and run underground to the electric meter. The electric service conduits shall be furnished and installed by the Contractor in a concrete duct bank.

B. Electric Service Conductors:

1. The electric service conductors shall be furnished and installed by the power company in the electric service conduit.

C. Electric Meter:

1. The electric meter shall be furnished by the power company. The meter box shall be furnished and installed by the Contractor.

D. Costs:

1. All power company costs for the installation of the new electric service will be paid by the Owner. The Contractor shall be responsible for all other costs associated with the installation of the new electric service.

END OF SECTION 16210

**SECTION 16500
LIGHTING FIXTURES**

PART 1 - GENERAL

1.01 DESCRIPTION

- A. Work Included:
1. Furnish all labor and materials for a complete lighting fixture installation as indicated on the Drawings and specified herein.
 2. Fixtures of size and type specified herein shall be supplied, installed and connected as indicated on the Drawings. Provide accessories for each fixture as required for a complete installation.
 3. Furnish and install LEDs in each fixture.

1.02 QUALITY ASSURANCE

- A. Regulations, Standards and Publications:
1. Fixtures shall be U.L. listed.
 2. All fixtures shall meet all Federal, State and local required criteria.
 3. All light fixtures shall be mounted in accordance with manufacturer's recommendations.
 4. The installation must comply with the amended National Electrical Code of the National Fire Protection Association.
- B. Qualification:
1. Provide manufacturer specified for each light fixture type. Substitutes will not be accepted without approval prior to the bid.
 2. When more than one name of manufacturer of fixture is listed in these specifications, the first manufacturer and number determine the style and quality.

1.03 SUBMITTALS

- A. Shop Drawings:
1. Submit manufacturer's latest publication of each fixture; construction details and light distribution details and/or coefficients.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. LED Drivers:
 - 1. LED light driver shall be high efficiency type.
 - 2. LED light driver shall allow operation of all other LEDs in the event of an LED failure.

- B. Light Fixture Schedule:
 - 1. SA: Pendant mounted, 120 volt, low profile high efficiency LED, nominal 8" x 4', totally enclosed gasketed fixture suitable for wet locations. Fixture shall be provided with an electronic driver. Fixture shall produce a minimum of 8,000 initial lumens and have a color temperature of 4000K. Housing shall be one-piece high impact plastic to provide durability and corrosion resistance. The lens shall be one-piece, low profile, frosted acrylic, resistant to damage. Fixture shall have plastic latches to apply positive, uniform pressure on the gaskets to seal against dust and moisture. Provide gasketed conduit hubs. Fixture shall be Holophane #EMSL48-8000LM-LPAFL-MD-MVOLT-GZ10-40K-80CRI-WLFEND2 or Lithonia #FEM-L48-8000LM-LPAFL-MD-MVOLT-40K-80CRI-WLFEND2.
 - 2. WA: Wall mounted, 120 volt, high efficiency LED fixture. The fixture shall produce a minimum of 8000 initial lumens and have a color temperature of 4000K. The fixture housing shall be constructed of die-cast copper-free aluminum with a bronze powder coated finish. Fixture shall have a tempered glass lens and be provided with photoelectric control. Fixture shall be Holophane #W4GLED-30C1000-40K-T3M-MVOLT-SPD-BZSDP-PE.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Installation:
 - 1. Contractor shall furnish and install supports for the light fixtures. Light fixtures shall be supported with formed channels, angles, rods, clamps, washers, etc. of sufficient size and strength to support weight of fixtures from the building overhead structural members, independently from the ceiling system.
 - 2. The fixture manufacturer's catalog numbers describing the various types of fixtures shall be used as a guide only and do not include all the required accessories or hardware that may be required for a complete installation.

The Contractor shall be responsible for furnishing, at no additional cost to the Owner, all required accessories and hardware for a complete installation.

3. All inoperable LEDs shall be replaced with new LEDs during the course of construction, up to and including the date of final acceptance by the Owner and Engineer.

END OF SECTION 16500

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**SECTION 16530
BATTERY EMERGENCY LIGHTING UNITS**

PART 1 - GENERAL

1.01 DESCRIPTION

- A. Work Included:
1. Furnish, install and connect a complete system of conduits, conductors, unit type battery emergency lighting units and all other materials and equipment necessary for the installation of an emergency lighting system.
 2. Provide manufacturer specified for each fixture type. Substitutes will not be accepted without approval prior to the bid.

1.02 QUALITY ASSURANCE

- A. Regulations, Standards and Publications:
- | | |
|-----|--|
| NEC | National Electrical Code of National Fire Protection Association |
| UL | Underwriters' Laboratories |
| FM | Factory Mutual Engineering Corp. |
- B. Qualification:
1. The complete system shall be of a type, which has been in satisfactory service for at least one year under automatic emergency lighting conditions.
 2. When more than one name of manufacturer of fixture is listed in these specifications, the first manufacturer and number determine the style and quality.

1.03 SUBMITTALS

- A. Shop Drawings:
1. Submit manufacturer's latest publication of the following:
 - a. Wet Location Battery Emergency Lighting Units
 - b. Battery Exit Fixtures

PART 2 - PRODUCTS

2.01 MATERIALS

A. Wet Location Battery Units:

1. EA: Battery emergency light fixtures shall have a nonmetallic housing. Fixture shall be provided with a test switch, status indicator and a rechargeable Nickel Cadmium battery. The battery shall provide 90 minutes of emergency illumination. Fixture shall operate on 120 volts and shall be furnished with two 2-watt LED lighting heads. Fixture shall be Holophane #DM30-WL-LED or Crouse-Hinds #N2LPSM212222.

B. Exit Fixtures:

1. EB: Exit fixtures shall be back mounted, single faced with red high intensity LED lamps and a sealed nickel cadmium battery. The fixture housing shall be white polycarbonate. The exit fixtures shall operate on 120 VAC power and shall be Holophane Magellan #QM-R-HORO or Sure-Lites #LPX7.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Battery Units:

1. Battery units shall be firmly fastened to walls. Mounting height to be determined in field.

B. Wiring:

1. Wiring on low voltage side of unit shall be no smaller than #10.
2. Connect battery emergency light fixtures to lighting circuit for area being protected ahead of all local control switches.

END OF SECTION 16530

**SECTION 16740
TELEPHONE SERVICE**

PART 1 - GENERAL

1.01 DESCRIPTION

- A. Work Included:
1. Furnish all labor and materials to install a complete new telephone service to the Clarifier Building including termination, conduit, and all equipment and labor required, as indicated on Drawings and specified herein.
 2. The telephone company is Verizon.

1.02 QUALITY ASSURANCE

- A. Contact telephone company for specific instructions regarding service requirements before beginning work. Complete system must meet with telephone company approval.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Service Conduit:
1. Service conduit shall be PVC Schedule 40 encased in a concrete duct bank, as indicated on the Drawings.
- B. Outlet Boxes:
1. Telephone outlet boxes and wall plates shall be same as used for all wiring devices. Wall plates shall be equipped with a telephone jack.

PART 3 - EXECUTION

3.01 INSTALLATION OF CABLE SERVICE

- A. Telephone Service Conduit:
1. Telephone service conduit shall start at the electric service pole and run underground to the telephone backboard in the Clarifier Building. Telephone service conduit shall be furnished and installed by the Contractor.

- B. Telephone Cable:
 - 1. The telephone cable shall be furnished and installed by the telephone company in the telephone service conduit.
- C. Telephone Backboard:
 - 1. Furnish and install a 2' x 4' x 3/4" plywood backboard in the Clarifier Building for mounting the telephone equipment.
- D. Ground:
 - 1. Provide a 3/4" conduit from the telephone backboard to the electric service ground for the telephone ground. Size of ground wire shall be as required by the telephone company.
- E. Conductors:
 - 1. All telephone conductors on the interior of the Clarifier Building shall be furnished and installed by the Contractor.
- F. Costs:
 - 1. All telephone company costs for the installation of the telephone service will be paid by the Owner.

END OF SECTION 16740

**SECTION 16900
EXHAUST FAN CONTROL PANEL**

PART 1 - GENERAL

1.01 DESCRIPTION

- A. Work Included:
1. Furnish and install an exhaust fan control panel as shown on the Drawings. The control panel shall be complete and include all components and wiring as shown on the Drawings and specified herein.

1.02 QUALITY ASSURANCE

- A. Regulations and Standards:
- | | |
|------|--|
| ANSI | American National Standards Institute |
| IEEE | Institute of Electrical and Electronic Engineers |
| ISA | International Society of Automation |
| NEC | National Electrical Code |
| NEMA | National Electrical Manufacturers Association |
| UL | Underwriters' Laboratories |
- B. The control panel components shall be of the most current and proven design. Specifications and Drawings call attention to certain features but do not purport to cover all details entering into the design of the control panels. The components shall be compatible with the functions required and shall form a complete working system.
- C. The control panels shall be UL listed as a complete assembly in accordance with UL-508.

1.03 SUBMITTALS

- A. Shop Drawings:
1. Submit shop drawings on the control panels in accordance with the General Requirements. Shop drawings shall be complete in all respects and shall include a complete bill of material, catalog information, descriptive literature of all components, wiring diagrams, and panel layout drawings showing dimensions to all devices.

PART 2 - PRODUCTS

2.01 CONTROL PANEL COMPONENTS

A. Control Panel Enclosure:

1. The control panel enclosure shall be designed and sized in accordance with the requirements of the Drawings and as specified herein. Control panel enclosures shall be manufactured by Hoffman, Saginaw, or Rittal.
2. Wall-mounted stainless steel control panel enclosures shall be NEMA Type 4X, constructed of 14 gauge, Type 316 stainless steel.
3. The control panel components shall be properly identified with an engraved nameplate mounted on the inside of the panel. All components not mounted on the front of the panel shall be mounted to a subpanel. All wiring shall be installed in a neat, workmanlike manner and shall be grouped, bundled, supported and routed horizontally and vertically to provide a neat appearance. All wires leaving the panel shall be terminated at the terminal strips inside the enclosure. Terminals and wires shall be identified in accordance with the panel wiring diagrams.
4. Provide a copper grounding plate inside the control panel for terminating all ground wires.
5. Provide a plastic data pocket inside each control panel.

B. Control Circuit Breakers:

1. Circuit breakers shall be quick-make, quick-break thermal magnetic molded case type, individually mounted and identified. Circuit breakers shall be Allen-Bradley Bulletin 1492-CB, or equal by Square D or Eaton.

C. Selector Switches:

1. Selector switches shall be 30.5mm, heavy-duty, non-illuminated. Switches shall have double-break silver contacts. Switches shall be maintained contact type unless otherwise indicated on the Drawings. Provide auxiliary contact blocks on switches, where indicated on the Drawings or in the Description of Operation. Provide a legend plate for each switch with white marking as indicated on the Drawings. Selector switches shall be Allen-Bradley Bulletin 800H, NEMA 4X, or equal by Square D.

D. Push Buttons:

1. Push buttons shall be 30.5mm, heavy-duty, non-illuminated. Push buttons shall have double-break silver contacts. Push buttons shall be momentary contact type, color-coded as indicated on the Drawings. Push buttons shall have flush heads. Provide a gray legend plate for each push button with

white marking as indicated on the Drawings. Push buttons shall be Allen-Bradley Bulletin 800H, NEMA 4X, or equal by Square D.

E. Pilot Lights:

1. Pilot lights shall be 30.5mm, heavy-duty, push to test, transformer type with LED lamps. Voltage rating shall be 120 volts. Lens color shall be as indicated on the Drawings. Provide a gray legend plate for each pilot light with white engraving as indicated on the Drawings. Pilot lights shall be Allen-Bradley Bulletin 800H, NEMA 4X, or equal by Square D.

F. Relays:

1. Relays shall be heavy-duty general-purpose type with 10 amp contacts. Relays shall have terminals, which plug-in to a socket, mounted to the inside of the panel enclosure. Terminals for relays having AC coils shall be pin type, and terminals for relays having DC coils shall be blade type. Contact configuration shall be 3PDT.
2. Relay coils shall operate on 120 volts AC or 24 volts dc as indicated on the Drawings.
3. Relays shall have an LED indicator light and a mechanical flag to indicate the relay coil is energized.
4. Relays shall be Idec RR Series, Eaton, or Zelio.

G. Fuses:

1. All fuses shall be sized as required for the circuit they are protecting. Fuses shall be Bussmann, touch-safe type, or equal.

H. Terminal Blocks:

1. Terminal blocks shall be provided in each control panel for terminating field wiring. All terminal blocks shall be rated for 600 volts AC and shall be identified with a permanent machine printed marking in accordance with the terminal numbers shown on the panel wiring diagrams.
2. Provide 20% spare terminal blocks in the control panel.
3. Terminal blocks shall be Allen-Bradley Bulletin 1492-W4, or equal.

I. Wiring:

1. All wiring shall be stranded copper. Control wiring shall be 16 gauge, 600 volt, Type MTW. Power wiring shall be 600 volt, Type MTW, sized as required.

2. All analog signal wiring shall be 18 gauge twisted pairs with foil shield and drain wire, with 300 volt, 90°C insulation. Drain wires shall be grounded at one end only.
 3. All wiring and terminal strips shall be isolated by voltage levels to the greatest extent possible.
 4. All wiring shall conform to the following color code:
 - a. 120 volt, 1 phase: Black, White
 - b. 120 VAC Control Wires: Red
 - c. Ground Wires: Green
 5. 120 VAC control wires energized from a source external to the control panel power source shall be yellow.
 6. All control wiring shall be tagged at each end with a legible permanent coded wire-marking sleeve. Sleeves shall be white PVC tubing with machine printed black marking. Markings shall be in accordance with the wire numbers shown on the control wiring diagrams, and shall match terminal strip numbers.
- J. Nameplates:
1. Provide laminated phenolic nameplates on the front of each control panel. Nameplates shall be black with white engraved letters. Engraving shall be as indicated on the Drawings. Minimum size of engraving shall be 1/4".

2.02 SPARE PARTS

- A. Provide the following spare parts for the control panel:
1. Six (6) fuses for each type and size utilized.
- B. Spare parts shall be packaged individually in boxes that are clearly labeled with part name and manufacturer's part/stock number.

PART 3 - EXECUTION

3.01 FIELD SERVICES

- A. Start-up and Testing:
1. Test the operation of the control panel and all controls.
 2. Start-up the control panel and place the control panel into operation.

3. All start-up and testing shall be performed in the presence of the Owner and the Engineer.

END OF SECTION 16900

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**SECTION 16920
INSTRUMENTATION**

PART 1 - GENERAL

1.01 DESCRIPTION

- A. Work Included:
1. Furnish and install all instrumentation and provide services as specified herein or as indicated on the Drawings.

1.02 QUALITY ASSURANCE

- A. Regulations and Standards:
- | | |
|------|--|
| UL | Underwriters' Laboratories |
| NEC | National Electrical Code |
| NEMA | National Electrical Manufacturers Association |
| ANSI | American National Standards Institute |
| IEEE | Institute of Electrical and Electronic Engineers |
| ISA | Instrument Society of America |
- B. All instrumentation equipment supplied shall be of the most current and proven design. Specifications and drawings call attention to certain features but do not purport to cover all details entering into the design of the instrumentation equipment. The equipment provided by the System Supplier shall be compatible with the functions required for the Process Control System.
- C. All necessary fuses and cables required for instrumentation equipment shall be provided with the equipment.

1.03 SUBMITTALS

- A. Shop Drawings:
1. Submit shop drawings on all instrumentation. Shop drawings shall be complete in all respects and shall indicate all dimensions, installation methods, size, weight, capacity, ratings, integral controls and types of materials, elevations, and sections. Submittals shall include a complete bill of material, catalog information, descriptive literature of all components and wiring diagrams.

PART 2 - PRODUCTS

2.01 INSTRUMENTATION

A. Magnetic Flow Meters:

1. Magnetic flow meters shall be of the low frequency and short form characterized coil design. The characterized field principle of electro-magnetic induction shall produce a positive DC pulsed signal directly and linearly proportional to the flow rate.
2. The metering tube shall be constructed of Type 304 stainless steel. The meter body shall be carbon steel. The flow meter shall have a flanged body to fit between ANSI Class 150 pipe flanges. The flow meter shall have a polyurethane liner and Type 316 stainless steel electrodes. The electrodes shall be flush mounted type. Liners and electrodes shall be suitable for raw water. Provide all required mounting hardware, stainless steel grounding rings and grounding straps for the installation of each magnetic flow meter.
3. The coils, which generate the field, shall be inside the pipe wall and shall be encapsulated in epoxy resin and encased behind the meter lining material. The ratio of flow velocity to reference voltage signals generated shall be compatible with the readout instrument without the necessity of circuit modifications. The meter shall have an average power consumption of 60 watts. Accuracy of the meter shall be $\pm 0.5\%$ of rate.
4. The meter housing shall be splash-proof and weather resistant design. The meter shall be capable of accidental submergence in up to 30 feet of water for up to 48 hours without damage to the electronics.
5. Complete zero stability shall be inherent characteristic of the meter system. This shall eliminate the requirement for valving downstream of the meter for creating a full pipe zero flow condition for calibration purposes. Meter systems requiring field zero adjustment will not be acceptable.
6. The magnetic flow meters shall be factory calibrated on an approved test stand with certified accuracy traceable to NIST, compliant with the ISO 17025 standard, and third party accreditation by a national verification agency such as A2LA. Calibration curves shall be submitted for each flow meter for 3 points within the specified flow range.
7. The flow meter shall have a remote mounted microprocessor based, NEMA 4X flow transmitter. The flow transmitter shall be powder coated cast aluminum. The flow transmitter shall have an LCD display to indicate the flow rate. The flow transmitter shall convert the meter's DC pulsed signal to a linear 4-20mA dc signal which is proportional to the flow rate.
8. The flow meter shall be capable of being programmed remotely using HART protocol.

9. The flow meter transmitter shall operate on a 120V AC, 60 Hz power source and shall have RFI protection. Provide a signal cable to connect the signal converter to the flow meter. Length of cable shall be as required for the installation (See Electrical Drawings).
10. The Magnetic Flow Meters shall be Endress & Hauser Proline Promag W400, or Rosemount Model 8750WA.

SCHEDULE OF MAGNETIC FLOW METERS

<u>Size</u>	<u>Flow Range</u>	<u>Location</u>	<u>Service</u>
6"	0 – 400 GPM	Clarifier Building	Raw Water Flow

B. Radar Level Transmitters:

1. The radar level transmitters shall reliably and accurately sense the water level in an open tank and shall provide for continuous level measurement.
2. The level transmitters shall have a PVDF housing with a threaded fitting and an encapsulated cable. The transmitter shall have a NEMA 4X/6P rating.
3. The level transmitters shall operate at a frequency of 80GHz using 2-wire technology for level measurement.
4. The level transmitter shall be a true 2-wire device with 24-volt DC power being derived from the control panel power supply. The transmitter output shall be a linear 4-20mA dc signal.
5. The transmitter shall have a measuring range up to 30 feet.
6. The transmitter shall be capable of operating in an ambient temperature range of -40 to +176 °F.
7. Provide a stainless steel mounting bracket for each level transmitter.
8. The radar level transmitters shall be VegaPuls C 21, or equal.

SCHEDULE OF RADAR LEVEL TRANSMITTERS

<u>Location</u>	<u>Service</u>
Flow Monitor Tank	Flow Monitor Tank Level
Sludge Collection Tank	Sludge Collection Tank Level

C. Float Switches:

1. Each float switch shall consist of a single pole, mechanical switch in a smooth, chemical resistant polypropylene casing with integral 2-wire cable. The switch shall be furnished in a normally open or closed configuration and shall be permanently molded to the signal cable at the factory. The float switches should be normally closed.
2. Signal cable shall be minimum #18 AWG. Length of cable shall be as indicated on schedule below.
3. Specific gravity of sensors shall be 0.95-1.10. Sensors shall remain operable at temperature down to 0°C and up to 90°C. The switch contacts shall operate on 24 volts DC.
4. Provide a 316 stainless steel mounting bracket for each float switch.
5. The float switches shall be Anchor Scientific Roto-Float or Conery.

SCHEDULE OF FLOAT SWITCHES

<u>Qty.</u>	<u>Type</u>	<u>Cable Length</u>	<u>Mounting Bracket</u>	<u>Service</u>
1	S	20 feet	WMS	Flow Monitor Tank High Level

D. Automatic Telephone Dialer:

1. The automatic telephone dialer shall be a 8-channel, solid state electronic, field programmable type with 6 hour 12vdc battery back-up.
2. Unit shall be programmable to dial up to nine 16-digit telephone numbers and shall be capable of dialing either local or long-distance calls.
3. Unit shall operate properly throughout a temperature range of 20°F to 130°F with a relative humidity of 0% to 95%.
4. Power requirements shall be 120 volt, 1 phase.
5. Unit shall operate over a standard private telephone line furnished by the telephone company.
6. Capacity for monitoring up to eight different alarm conditions shall be furnished. Alarms shall be transmitted separately using code numbers in conjunction with the station identification. When any of the eight alarm conditions exist at the station, the dialer shall automatically call the

programmed telephone numbers continuously until one of the numbers answers. At that time, the dialer, through computer type synthesized voice, shall deliver a message indicating location of alarm and which alarm code number exists. After the answering party has received the dialer's message, they shall be required to dial specific code numbers on the receiving telephone to acknowledge the alarm condition. After acknowledgment, the dialer shall automatically go into a delay mode (field programmable from 1 to 99 hours) to allow time for the alarm condition to be corrected. If the alarm condition has not been corrected (or disabled using the selector switch provided on the alarm panel), the automatic dialer shall start the dialing sequence again. If a different alarm condition occurs during the delay mode, the dialer shall ignore the delay set point and automatically dial the programmed numbers and communicate the new alarm condition. After acknowledgment, the same sequence may be repeated for up to a total of eight different alarm conditions.

7. Dialer shall be capable of being interrogated at any time by calling the dialer from any location. When interrogated, the unit shall inform the caller of any and all existing alarm conditions or give a "normal" or "station clear" announcement.
8. Alarm messages shall be repeated six times when dialer's call is answered and repeated three times when dialer is interrogated.
9. Unit shall be field programmed with voice vocabulary to announce the location of and description of the alarm condition.
10. All alarms interfaced with automatic dialer shall be able to be manually disabled with the exception of "power failure". A "power failure" alarm will start the automatic dialing sequence every time it occurs and must be acknowledged each time.
11. Unit shall be furnished with a delayed fault recognition feature to eliminate false alarms due to slow response times of valves, etc. Time delay shall be adjustable from 0-60 seconds.
12. Unit shall be furnished with a fault "lock-in" feature that continues the calling sequence until the fault is acknowledged, even if fault clears itself before call sequence is answered.
13. The dialer shall be furnished with a surge suppressor for the AC power and telephone lines.
14. The automatic telephone dialer shall be RACO Verbatim, or Cattron.

2.02 INSTRUMENT NAMEPLATES

- A. Provide a laminated phenolic nameplate for each instrument. The nameplates shall be black with white engraved letters, and they shall be mounted on the front of

each instrument or instrument enclosure, or where applicable attached to the instrument with a plastic wire tie. An instrument nameplate schedule shall be submitted to the Engineer for approval prior to performing any engraving.

PART 3 - EXECUTION

3.01 INSTALLATION ASSISTANCE AND INSPECTION

- A. Provide the services of manufacturer's service representatives to assist in installation for all instrumentation specified herein.
- B. Each manufacturer's representative shall inspect the installation of each of their instruments, and shall issue an installation certificate to the Owner and the Engineer for each instrument certifying that the instrument has been installed in accordance with the manufacturer's recommendations.

3.02 CALIBRATION

- A. Provide the services of manufacturer's service representatives to calibrate all instrumentation provided. All calibration shall be performed in the presence of the Owner and the Engineer. The calibration of each instrument shall be performed after the instrument installation certificate has been issued.
- B. Each manufacturer's representative shall issue a calibration certificate to the Owner and the Engineer for each instrument certifying that the instrument has been calibrated and is ready to be placed into service. The calibration certificates shall indicate the calibrated range or setpoint for each instrument.

3.03 TRAINING

- A. Provide four (4) hours of training on the instrumentation provided.
- B. All training shall be performed by a representative from the manufacturer and shall be specific to the instruments provided. Training shall include theory of operation, maintenance requirements, and calibration methods.

END OF SECTION 16920