For the Construction of

WESTERN AREA WWTP PHASE 1 EXPANSION

HUNTSVILLE, ALABAMA

COH PROJECT NO. 71-22-SF01

Garver Project No. 21W10220

VOLUME 2 OF 5
DIVISIONS 26 - 46
WESTERN AREA WWTP PHASE 1 EXPANSION
GARVER PROJECT NO. 21W10220
CLIENT PROJECT NO. 71-22-SF01

I hereby certify that the applicable portions of this project plans and specifications were prepared by me or under my direct supervision and that I am a duly Licensed Engineer under the laws of the State of Alabama.

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Digitally Signed: 06/14/2022
### SEAL AND SIGNATURE

| Ben Ross, P.E. | Division 22  
| Division 23 |

Digitally Signed: 06/14/2022

| Jonathan White, P.E. | Division 26 |

Digitally Signed: 06/14/2022

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### GARVER, LLC CERTIFICATE OF AUTHORIZATION:

**AL ENGINEERING COA NO. 500-E**

Expiration Date: 12/31/2023
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PART 1 - GENERAL

1.1 SUMMARY

A. This Section specifies the basic requirements for electrical installations and includes requirements common to more than one section of Division 26. It expands and supplements the requirements specified in the General and Supplementary Conditions.

B. This project consists of construction of the new building structures, associated facilities, and all related electrical systems as defined in the plans and in these specifications.

C. The work includes the installation, connection and testing of new electrical equipment, including electrical services, power distribution equipment, lighting equipment, underground electrical work, grounding systems, control systems, conduit and wiring, coordination of traffic flow, temporary power systems, special electrical systems and all appurtenances to construct and demonstrate proper operation of the completed electrical systems.

D. The Contractor shall be responsible for the coordination of power, communication, and controls for the project.

E. The electrical plans do not give exact locations, etc., and do not show all the offsets, control lines, pilot lines, and other installation details. Each contractor shall carefully lay out the work at the sites to conform to the job conditions, to conform to details of installation supplied by the manufacturers of the equipment to be installed, and thereby to provide complete operating systems.

F. The electrical plans show diagrammatically the locations of the various electrical outlets and apparatus and the general method of circuiting and controlling. Exact locations of these outlets and apparatus shall be determined by reference to the general plans and to all detail drawings, etc., by measurements at the buildings, and in cooperation with other crafts, and in all cases shall be subject to the approval of the Owner and Engineer. The Engineer reserves the right to make any reasonable change in location of any outlet or apparatus before installation, without additional cost to the Owner.

G. These specifications and the accompanying drawings are intended to cover systems which will not interfere with the structure of the buildings, which will fit into the several available spaces, and which will ensure complete and satisfactory systems. Each bidder shall be responsible for the proper fitting of the material and apparatus into the buildings.

H. Should the particular equipment which any bidder proposes to install require other space conditions than those indicated on the Drawings, the Bidder shall arrange for such space with the Engineer before submitting the bid. Should changes become necessary on account of failure to comply with this clause, the Contractor shall make such changes at the Contractor’s expense.

I. Where wire sizes, conduit and other items of construction are shown or required for a complete installation, but are not adequately identified as to size or material requirements, the materials furnished shall be in accordance with “Code” requirements as though shown in detail on the Drawings.

J. All equipment shall be leveled and made plumb. Metal junction boxes, equipment enclosures and metal raceways mounted on water or earth-bearing walls shall be separated from walls not less than 1/4 inch by corrosion-resistant spacers. All electrical conduits and items of equipment shall be run or set parallel to walls, floors and other items of construction.
1.2 STANDARDS

A. The Contractor shall perform work specified in Division 26 in accordance with standards listed below. Where these specifications are more stringent, the most stringent standard shall take precedence. In case of conflict, obtain a decision from the Engineer.

1. Applicable National Fire Protection Association (NFPA) codes, including but not limited to:
   e. NFPA 820 – Standard for Fire Protection in Wastewater Treatment and Collection Facilities.
   f. Internet Website: http://www.nfpa.org

2. Applicable Code of Federal Regulations (CFR) codes, including but not limited to:
   b. 29 CFR 1926 – Safety and Health Regulations for Construction.
   c. Internet Website: http://www.gpo.gov/fdsys


4. Applicable Federal, State and Local Fire codes.

5. Applicable Federal, State and Local Energy Codes.

6. Applicable Federal, State and Local Building Codes.

7. Applicable City Electrical Code.

8. Applicable City Ordinances pertaining to electrical work.


B. Contractor shall utilize the most current editions of standards, which are current at time of bid and as recognized by the Authority Having Jurisdiction for the respective standard.

1.3 SUBMITTALS

A. Submittals shall comply with Section 01 33 00 SUBMITTAL PROCEDURES and the General and Supplementary Conditions.

B. Submittals shall be furnished by the Contractor for the work involved in sufficient time so that no delay or changes will be caused. Fax copies are not acceptable.

C. Submittals shall consist of manufacturing information, schematics, wiring diagrams, ladder logic diagrams, instrument loop diagrams, outline drawings, clearances and related information. Shop Drawings shall be so marked as to indicate the EXACT items offered.

D. Submittals shall bear Contractor’s certification that the item complies in all respects with the item originally specified. It is the Contractor’s responsibility to procure the proper sizes, quantities, rearrangements, structural modifications or other modifications in order for the substituted item to comply with the established requirements.

E. The Contractor shall combine each submittal set into one electronic file (pdf format). Group materials submitted by their Specification numbers, but do not submit the entire electrical within one submittal. Provide electronic bookmarks in the pdf to indicate the included equipment types and a title sheet to separate each section.

F. The Contractor shall submit complete descriptions, illustrations, specification data, etc., of all materials, fittings, devices, fixtures, special systems, etc., as required by the individual sections of this Division.
G. Submittal of shop drawings, product data and samples will be accepted only when submitted by the Contractor. Data submitted from subcontractors and material suppliers directly to the Engineer will not be processed.

H. All submittals shall provide the following information:
   1. General Contractor.
   2. Sub-Contractor.
   3. Distributor and/or Supplier.
   4. Sales Agency.
   5. Submittals not supplying this information will be rejected.

I. Shop Drawings: In addition to the above, submit shop drawings for major materials where called for and when requested by the Engineer.
   1. Lockout/Tagout Program.
   2. Switchboard, motor control centers, panelboards, surge arresters, and safety switches.
   3. Motor starters and contactors including custom wiring diagrams for all motors.
   4. Lighting fixtures and lamps including light pole foundation requirements.
   5. Wire, cable and conduit.
   6. Dry type transformers including weight and dimensions.
   7. Wiring devices and plates.
   8. Dimensioned layout of electrical room drawn to scale, with equipment location shown therein. Clearances shall be in accordance with NEC and local codes.
   9. Dimensioned layout of all below grade conduit installations.
  10. Grounding system and layout.
  11. Lightning protection system layout.
  12. Traffic control system layout and schematics.
  13. Seismic protection materials and methods for all electrical equipment.
  14. Mounting brackets, supports and assembly for walkway mounted equipment including instruments, lighting and control panels

1.4 QUALITY ASSURANCE

A. Any electrical equipment provided under this Division shall be turned over to the Owner in operating condition. Instruction on further operation and maintenance shall be included in the operating and maintenance instructions.

1.5 PRODUCT LISTING

A. Prepare listing of major electrical equipment and materials for the project.

B. Provide all information requested.

C. Submit this listing as a part of the submittal requirements.

D. When two or more items of same material or equipment are required they shall be of the same manufacturer when available. Product manufacturer uniformity does not apply to raw materials, bulk materials, wire, conduit, fittings, sheet metal, steel bar stock, welding rods, solder, fasteners, motors for dissimilar equipment kits, and similar items used in Work, except as otherwise indicated.

E. Provide products that are compatible within systems and other connected items.
1.6 NAMEPLATE DATA

A. Provide permanent operational data nameplate on each item of power operated equipment, indicating manufacturer, product name, model number, serial number, capacity, operating and power characteristics, labels of tested compliances, and similar essential data. Locate nameplates in an accessible location.

1.7 WORK SUPERVISION

A. The Contractor shall designate in writing the qualified electrical supervisor who shall provide supervision to all electrical work on this project. The minimum qualifications for the electrical supervisor shall be a master electrician as defined by the statutes of the State of the work being performed. The supervisor or his appointed alternate possessing at least a master electrician license shall be on site whenever electrical work is being performed. The qualifications of the electrical supervisor shall be subject to approval of the Owner and the Engineer.

B. All master and journeyman electricians shall be licensed in accordance with the statutes of the State of the work being performed. No unlicensed electrical workers shall perform work on this project. Apprentice electricians in a ratio of not more than one apprentice per journeyman electrician will be allowed if the apprentices are licensed and actively participating in an apprentice-ship program recognized and approved by the statutes of the State of the work being performed.

1.8 PRIMARY SERVICE

A. The Contractor shall provide primary service trenching and conduit as indicated on the drawings per electric utility company standards. Contractor is responsible for coordinating conduit and trench requirements with the electric utility company.

1.9 SECONDARY SERVICE

A. New electrical work shall be as noted in the drawings. Services shall be 480Y/277 volt, three-phase, four-wire grounded as indicated. All secondary services are to be furnished and installed by the contractor.

B. The Contractor shall be responsible for coordinating all electrical work with the servicing utility prior to construction and providing all equipment, transformer pads, connectors, and accessories to make all final secondary connections.

C. The Contractor shall provide temporary service conductors and raceway system as may be required. The Contractor shall then provide and connect permanent service conductors and raceway system after the permanent installation. The Contractor shall coordinate temporary service, installation, metering and all other items as required with the servicing utility. The Contractor shall be responsible for paying all temporary electric monthly metering charges.

D. Service entrance electrical ducts shall be red blended concrete encased at a depth to provide 18 inches minimum cover over the top of the underground electrical duct, regardless of the soil conditions or substances encountered.

1.10 TELEPHONE WORK

A. The Contractor shall be responsible for coordinating all telephone work with the servicing utility, Owner and Engineer.
1.11 LOCKOUT / TAGOUT PROGRAM

A. The Contractor shall provide a complete copy of and electrical energy source Lockout/Tagout Program to the Owner, with copy to the Engineer. The document shall clearly identify the on-site master electricians and their contact information, including office and mobile telephone numbers.


C. Implementation of the Lockout/Tagout Program and all other related safety requirements are the sole responsibility of the Contractor.

1.12 SAFETY PROGRAM

A. The Contractor shall implement an electrical safety program that complies with NFPA 70E and 29 CFR 1926.

B. Implementation of the Electrical Safety Program, determining and providing proper Personal Protective Equipment (PPE), training and enforcing personnel to wear the prescribed PPE, conducting work area safety inspections (including correcting deficiencies), and all other related safety requirements are the sole responsibility of the Contractor.

1.13 EQUIPMENT CONNECTIONS

A. General: Provide connections for all equipment installed or modified by this contract, regardless of who furnished the equipment.

B. Provide all disconnect switches required by Code whether or not shown on the plans.

C. Contractor shall connect Owner-furnished equipment when specified.

1.14 GENERAL CONDITIONS

A. The work under this heading is subject to the General and Supplementary Conditions, special conditions for mechanical and electrical work, and the Contractor or subcontractor will be responsible for and be governed by all requirements thereunder as though specifically repeated herein.

1.15 COORDINATION

A. The Contractor shall coordinate arrangement, mounting and support of all electrical equipment:
1. To allow maximum possible headroom unless specific mounting heights are indicated.
2. To provide for ease of disconnecting the equipment with minimum interference to other installations.
3. To allow right of way for piping and conduit installed at a required slope.
4. So connecting raceways, cables and wireways will be clear of obstructions and of the working and access space of other equipment.

B. The Contractor shall coordinate electrical equipment to be mounted on vendor supplied walkways with supplier.
1.16 SPECIAL NOTE

A. The mechanical, structural and process plans and specifications, including the general conditions and all supplements issued thereon, information to bidders, and other pertinent documents issued by the Engineer, are a part of these specifications and the accompanying electrical plans, and shall be complied with in every respect. All the above is included herewith, and shall be examined by all bidders. Failure to comply shall not relieve the Contractor of responsibility or be used as a basis for additional compensation due to omission of mechanical, process and structural details from the electrical drawings.

1.17 CONTINUATION OF SERVICES

A. The Contractor shall install any temporary lines and connections required to maintain electric services and safely remove and dispose of them when complete. The Contractor shall supply emergency power whenever any existing electrical service is without power. In general, the existing facility shall remain operational during construction.

B. Planned outages shall be coordinated two weeks in advance with duration and time of start approved by the Owner. Changeover work which may be required after normal hours or weekends shall not constitute the basis for additional cost to the Owner. When an outage begins, the Contractor shall proceed directly to completion of the work without unscheduled interruptions or delays due to lack of manpower, equipment or tools.

C. The Contractor shall refer to the sequence of construction and shall provide temporary connections as may be required to complete each phase of construction as may be required. The Contractor shall submit proposed electrical service plans for each phase of construction to the Owner and Engineer for consideration.

1.18 LAYOUT

A. The Contractor shall coordinate and establish all bench marks and control lines. The Contractor shall lay out all work. The lay out shall be reviewed by the Engineer and Owner prior to starting any work.

1.19 RELATED WORK SPECIFIED ELSEWHERE

A. Mechanical Equipment: The Contractor shall rough-in for and make final electrical connections to all motor, panels, fixtures, and equipment furnished under other sections of the specifications, providing all material and equipment required for such final connections, except hereinbefore described. This includes, but is not limited to, control panels and other miscellaneous equipment.

B. The Contractor shall refer to other sections of these specifications for all information relating to the requirements of all electrical connections to the equipment and shall furnish and install electrical items required for a complete installation, ready for operation.

C. Roughing-in shall be accomplished from approved shop drawings.

D. Verify final locations for rough-ins with field measurements and with the requirements of the actual equipment to be connected.

E. Refer to equipment specifications in other Divisions for rough-in requirements.
1.20 LOCAL CONDITIONS

A. Inspection of Sites: The bidder shall inspect the site, thoroughly acquaint himself with conditions to be met and work to be accomplished. Failure to comply with this shall not constitute grounds for any additional payments.

1.21 RECORD DOCUMENTS

A. Refer to the General and Supplementary Conditions for requirements. The following paragraphs supplement the requirements of the General and Supplementary Conditions:

1. Mark Drawings to indicate revisions to conduit size and location both exterior and interior; actual equipment locations, dimensioned for column lines; concealed equipment, dimensioned to column lines; distribution and branch electrical circuitry; fuse and circuit breaker size and arrangements; support and hanger details; Change Orders; concealed control system devices.

2. The Contractor shall locate all underground and concealed work, identifying all equipment, conduit, circuit numbers, motors, feeders, breakers, switches, and starters. The Contractor will certify accuracy by endorsement. Record drawings shall be correct in every detail, such that the Owner can properly operate, maintain, and repair exposed and concealed work.

3. The Contractor shall store the Record drawings on the site. Drawings shall not be rolled. Make corrections, additions, etc., with pencil, with date and authorization of change.

4. Mark specifications to indicate approved substitutions; Change Orders; actual equipment and materials used.

1.22 OPERATION AND MAINTENANCE DATA

A. Refer to Section 01 33 00 SUBMITTAL PROCEDURES and Section 01 78 23 OPERATION AND MAINTENANCE DATA for procedures and requirements for preparation and submittal of maintenance manuals.

B. In addition to the information required by Sections 01 33 00 and 01 78 23, include the following information:

1. Installation manual: Description of function, installation and calibration manuals, normal operating characteristics and limitations, performance curves, engineering data and tests, and complete nomenclature and commercial numbers of all replaceable parts.

2. Operations manual: Manufacturer’s printed operating instructions and procedures to include start-up, break-in, routine and normal operating instructions; regulation, control, stopping, shutdown, and emergency instructions; summer and winter operating instructions; and all programming and equipment settings.

3. Maintenance manual: Maintenance procedures for routine preventative maintenance and troubleshooting; disassembly, repair, and reassembly; aligning and adjusting instructions.

4. Service manual: Servicing instructions and lubrication charts and schedules, including the names and telephone numbers of personnel to contact for both routine periodic and warranty service for equipment and materials provided under this Division.

5. Final approved equipment shop drawings, clearly labeled.

6. Final test reports, clearly labeled, including motor certification tests.

7. Final certified calibration sheets for all equipment and instruments.

C. After approval of the O&M Manuals, the Contractor shall provide three (3) complete electronic copies of all documentation in Adobe PDF file format using a storage media device of the Owner and Engineer’s choosing.
1.23 GUARANTEE

A. The Contractor shall guarantee the work and materials for a period of one (1) year from the date of completion. If there are failures due to faulty material or workmanship, the Contractor shall correct the failure at no cost to the Owner.

B. Refer to the General and Supplementary Conditions for procedures and submittal requirements for warranties. Refer to individual equipment specifications for warranty requirements.
   1. Compile and assemble the warranties specified in Division 26, into a separate set of vinyl covered, three ring binders, tabulated and indexed for easy reference.

C. Provide complete warranty information for each item to include product or equipment to include date of beginning of warranty or bond; duration of warranty or bond; and names, addresses, and telephone numbers and procedures for filing a claim and obtaining warranty services.

D. Upon completion of the installation, the Contractor shall adjust the systems to the satisfaction of the Engineer.

E. This guarantee shall include the capacity and integrated performance of the component parts of the various systems in accordance with the intent of the specifications. The Contractor shall conduct complete tests required by the Engineer to demonstrate the ability of the various systems.

1.24 CLEANING

A. Refer to Section 01 77 00 CLOSEOUT PROCEDURES for general requirements for final cleaning.

B. Clean all light fixtures, lamps and lenses prior to final acceptance. Replace all inoperative lamps.

C. The electrical system shall be thoroughly cleaned inside and outside, of all enclosures to remove all debris, dust, concrete splatter, plaster paint and lint.

PART 2 - PRODUCTS

2.1 MATERIALS AND EQUIPMENT

A. All materials and equipment used in carrying out these specifications shall be new and have UL listing, or listing by other recognized testing laboratory when such listings are available. Specifications and drawings indicate name, type, or catalog numbers of materials and equipment to be used as standards.

2.2 HEAT TRACING

A. Heat trace and insulate all exposed piping, water lines, and valves less than 8” diameter and all equipment where water may collect. Where exact sizes, panels, boxes, conduit, circuitry and other items of construction are shown or required for a complete installation, but are not adequately identified as to size or material requirements, the materials furnished shall be as needed to provide freeze protection requirements as though shown in detail on the Drawings. The Contractor shall be responsible for supplying all items as required for complete heat tracing systems regardless of the level of detail shown on the Drawings.

B. Contractor shall meet all National Electrical code requirements for heat tracing and particularly to Resistance Heating Elements Article 427-21, 22 and 23.
PART 3 - EXECUTION

3.1 SALVAGE

A. All salvage and equipment removed by the work shall remain the property of the Owner unless directed otherwise by the Owner. Material removed from the project shall be stored on the project site where and as directed. Debris shall be removed from the job site and disposed of by the Contractor.

3.2 DEMOLITION AND DISPOSAL

A. All conduit, wire, and other electrical appurtenances associated with equipment removed in this project, and no longer in use, shall be removed and stored or disposed of as directed by the Owner. The Contractor shall patch and apply finish to walls, floors, and other structures from which such items are removed to match surrounding colors, textures, or other visual characteristics.

3.3 DELIVERY, STORAGE, AND HANDLING

A. Deliver equipment to project properly identified with names, model numbers, types, grades, compliance labels, and similar information needed for distinct identifications; adequately packaged and protected to prevent damage during shipment, storage, and handling.

B. Store equipment and materials at the site, unless off-site storage is authorized in writing. Protect stored equipment and materials from damage.

C. Equipment and materials shall be stored in accordance with the manufacturer’s recommendations and instructions.

D. All equipment, including but not limited to equipment containing coils and/or electronics, shall be stored in a clean, dry, ventilated and heated building. The storage area shall be free from condensation or other injurious environmental conditions. Freedom from condensation shall be essential and shall be accomplished by the use of auxiliary heaters as required to raise the temperature to 5-degree C above the ambient temperature. The equipment shall be protected from excessive dust.

E. In addition, certain electronic equipment that requires cooling based upon its specific storage temperature range shall be stored in an air-conditioned building.

F. All motors shall be stored in a clean, dry, ventilated and heated building. The storage area shall be free from condensation or other injurious environmental conditions. Freedom from condensation shall be essential and shall be accomplished by the use of auxiliary heaters as required to raise the temperature to 5 degree C above the ambient temperature. The motors shall be protected from excessive dust.

G. Cables and wiring shall be kept in a dry location out of the sun.

H. Outdoor storage, even when protected by a tarpaulin, is unacceptable.

I. Equipment may be rejected if the storage criteria are not followed.

3.4 INSTALLATION

A. Coordinate electrical equipment and materials installation with other building components.
B. Verify all dimensions by field measurements.

C. Arrange for chases, slots, and openings in other building components to allow for electrical installations.

D. The Contractor shall keep ends of conduits, including those extending through roofs, equipment and fixtures covered or closed with caps or plugs to prevent foreign material from entering during construction.

E. Coordinate the installation of required supporting devices and sleeves to be set in concrete and other structural components as they are constructed.

F. Sequence, coordinate, and integrate installations of electrical materials and equipment for maintaining the required operation of the facility. Give particular attention to large equipment requiring positioning prior to closing-in the building.

G. Coordinate the cutting and patching of building components to accommodate the installation of electrical equipment and materials.

H. Where mounting heights are not detailed or dimensioned, install electrical services and overhead equipment to provide the maximum headroom possible.

I. Install electrical equipment to facilitate maintenance and repair or replacement of equipment components. As much as practical, connect equipment for ease of disconnecting, with minimum of interference with other installations.

J. Coordinate the installation of electrical materials and equipment above ceilings with suspension system, mechanical equipment and systems, and structural components.

K. Coordinate connection of electrical systems with exterior underground and overhead utilities and services. Comply with requirements of governing regulations, franchised service companies, and controlling agencies. Provide required connection for each service.

L. Coordinate installation of electrical equipment on vendor supplied walkways with supplier.

3.5 MATERIALS AND WORKMANSHIP

A. All materials shall be new, and shall be of the latest standard design of a manufacturer regularly engaged in the manufacture of that type of equipment. Materials shall be in good condition and shall be free from dents, scratches or other damage incurred in shipment or installation.

B. All equipment shall comply with the National Electrical Code, Underwriters Laboratories or other appropriate agency.

C. Installation shall be made in a neat and workmanlike manner, and all materials shall be installed in accordance with the recommendations of the various manufacturers. The installation shall be subject to the approval of the Owner and Engineer.

D. Incidental materials required to complete the installation as intended by these Specifications shall be of the type and quality in keeping with specified equipment.
3.6 COORDINATION

A. Carefully examine specification and drawings to be thoroughly familiar with items which require electrical connections and coordination. (Electrical drawings are diagrammatic and shall not be scaled for exact sizes.)

B. Notify other tradesmen of any deviations or special conditions necessary for the installation of work. Interference between work of various contractors shall be resolved prior to installation. Work installed not in compliance with specifications and drawings and without properly checking and coordinating as specified above shall, if necessary, be removed and properly reinstalled without additional cost to the Owner. Engineer to be mediating authority in all disputes arising on project.

C. Equipment shall be installed in accordance with manufacturer’s recommendation. Where conflicts occur between contract documents and these recommendations, a ruling shall be requested of the Engineer for decision before proceeding with such work.

3.7 CUTTING AND PATCHING

A. Repair or replace routine damage caused by cutting in performance of work under this Division.

B. Correct unnecessary damage caused due to installation of electrical work, brought about through carelessness or lack of coordination.

C. Holes cut through floor slabs to be sleeved or core drilled with drill designed for this purpose. All openings, sleeves, and holes in slabs to be properly sealed, fire proofed and water proofed.

D. Repairs to be performed with materials which match existing materials and to be installed in accordance with appropriate sections of these specifications.

E. All cutting and patching work shall be coordinated in advance with the Engineer and Owner prior to any work.

3.8 TRENCHING, EXCAVATION, BACKFILLING, AND REPAIRS

A. Provide trenching, excavation, and backfilling necessary for performance of work under this Division.

3.9 FOUNDATIONS AND PADS

A. Foundations and pads required for equipment shall be provided as indicated. Proper size and location of foundations, pads and anchor bolts shall be determined under this Division.

B. Provide anchors and bases for electrical equipment to withstand lateral forces and accommodate displacements.

3.10 NOISE AND VIBRATION CONTROL

A. The electrical system as installed shall be free of objectionable noise or vibration. The Contractor shall isolate motors, starters, transformers, equipment, ballasts, etc., as directed or required as to ensure acceptable noise level free from objectionable vibration in all systems.
3.11 TESTS

A. On completion of work, installation shall be completely operational and entirely free from ground, short circuits, and open circuits. Perform a thorough operational test in presence of the Owner and Engineer. Furnish all labor, materials and instruments for above tests.

B. Furnish the Engineer, as part of closing file, a copy of such tests including identification of each circuit and readings recorded. Test information to be furnished to the Engineer includes ampere readings of all panels and major circuit breakers, isolation resistance reading of motors and transformers.

C. Prior to final observation and acceptance test, all electrical systems and equipment shall be in satisfactory operating condition. Including, but not limited to the following:
   1. Electrical power and distribution system.
   2. Lighting systems.
   3. Transformers.
   4. Electric motors for all equipment.
   5. Telecommunication system.
   6. Emergency power system.
   7. Special electrical control systems.

D. After installation of the electrical system and before operating equipment, functional checking shall be conducted in accordance with the manufacturer’s recommendations, with the contract drawings and as follows:
   1. Functional checking shall include inspection, testing and repair, replacement or adjustments as necessary to ensure compliance with the requirements of the specifications. Tests and inspections shall be recorded on appropriate yellow lined contract and shop drawings, standard test forms and checklists to indicate that wiring and controls are in place in accordance with requirements and to form the basis of record drawings.
   2. The functional test procedures shall be signed and dated by the Contractor and presented to the Owner’s construction observation personnel prior to operating any equipment.
      a. Visual Inspection – The electrical system shall be examined as outlined below:
         1). Parts of components missing
         2). Improper assembly
         3). Parts or components not functioning properly
         4). Finish not as specified
         5). Materials not as specified
         6). Connections not tight
         7). Mounting and supports loose or unsatisfactory
         8). Nameplates missing or inaccurate
      b. Grounding System Tests
         1). Measure the resistance of the counterpoise grounding system by the rate-of-fall of potential method. Record all measurements on an approved standard test form made specifically for the purpose. The resistance of the grounding system to ground shall not exceed NFPA 70 requirements.
      c. Continuity Tests
         1). Each wire and each wire in each cable rated 300 volts and below shall be tested for continuity. Record wire number and pass or fail on checklist for each wire.
      d. Dielectric Tests
         1). Each power conductor rated 600 volts and above shall be tested (meggered) for dielectric strength to ground.
         2). Prior to testing, all components that could be damaged should be disconnected. After testing, the circuit shall still register a resistance value of not
less than 1 megohm at 600 volts, dc. This test shall apply between all insulated circuits and external metal parts. Record equipment name, phase or wire number and all observed values for each wire.

3). Subsequent to wire and cable hook-ups, energize circuits and demonstrate proper functioning of all circuits. Record equipment or circuit number and pass or fail on function test checklist for each circuit.

4). The Contractor shall develop non-conforming material reports for each failure. Repair and report failures all failures to Owner and Engineer.

5). The Contractor shall replace defective parts, correct malfunctioning units, make all repairs and retest to demonstrate compliance. The Contractor shall document all actions taken on appropriate non-conforming material report.

3.12 INSPECTION FEES AND PERMITS

A. Obtain and pay for all necessary permits and inspection fees required for electrical installation.

3.13 IDENTIFICATION OF EQUIPMENT

A. Properly identify all electrical equipment, including but not limited to the following:
   1. Switchgear, switchboards, motor control centers, and control panels.
   2. Main distribution panel and individual devices within it.
   3. Panelboards and individual devices within it.
   4. Safety switches and disconnects.
   5. Contactors and lighting control center, including all branch circuits.
   6. Individually mounted circuit breakers.
   7. Relays.
   8. Transformers.
   10. Any other type of enclosure that includes electrical equipment.

3.14 TEMPORARY LIGHTS AND POWER

A. Provide a temporary electrical lighting and power distribution system of adequate size to properly serve temporary requirements. Temporary work to be installed in a neat and safe manner in accordance with the National Electrical Code, Article 590, and as required by OSHA or applicable local safety codes.

END OF SECTION
SECTION 26 05 14 - WIRING DEVICES

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:
   1. Receptacles with integral GFCI and associated device plates.
   2. Snap switches and wall-box dimmers.

1.2 DEFINITIONS

A. EMI: Electromagnetic interference.

B. GFCI: Ground-fault circuit interrupter.

C. Pigtail: Short lead used to connect a device to a branch-circuit conductor.

D. RFI: Radio-frequency interference.

E. TVSS: Transient voltage surge suppressor.

1.3 SUBMITTALS

A. Product Data: for each type of product indicated.

B. Shop Drawings: List of legends and description of materials and process used for pre-marking wall plates.

C. Samples: One for each type of device and wall plate specified in each color specified.

D. Field quality-control test reports.

E. Operation and Maintenance Data: For wiring devices to include in all manufacturers’ packing label warnings and instruction manuals that include labeling conditions.

1.4 QUALITY ASSURANCE

A. Source Limitations: Obtain each type of wiring device and associated wall plate through one source from a single manufacturer. Insofar as type are available, obtain all wiring devices and associated wall plates from a single manufacturer and one source.

B. Electrical Components, Devices and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction and marked for intended use.

C. Comply with NFPA 70.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Available Manufacturers:
   1. Cooper wiring Devices; a division of Cooper Industries, Inc. (Cooper).
   2. Hubbell Incorporated; Wiring Device-Kellems (Hubbell).
4. Pass & Seymour/Legrand; Wiring Devices & Accessories (Pass & Seymour).

2.2 STRAIGHT BLADE RECEPTACLES

A. Convenience Receptacles, 125 V, 20A: Comply with NEMA WD1, NEMA WD 6 configuration 5-20R, and UL 498.
   1. Available Products: Subject to compliance with requirements, products that may be incorporated into the work include, but are not limited to the following:
      a. Cooper; 5351 (single), 5352 (duplex).
      b. Hubbell; HBL5351 (single), CR5352 (duplex).
      c. Leviton; 5891 (single), 5352 (duplex).
      d. Pass & Seymour; 5381 (single), 5352 (duplex).

2.3 GFCI RECEPTACLES

A. General Description: Straight blade, feed-through type. Comply with NEMA WD1, NEMA WD6, UL498 and UL 943, Class A and include indicator light that is lighted when device is tripped.

B. Duplex GFCI Convenience Receptacles, 125 V, 20A:
   1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to the following:
      a. Cooper; GF20.
      b. Pass & Seymour; 2084.

2.4 SNAP SWITCHES

A. Comply with NEMA WD 1 and UL 20.

B. Switches, 120/277 V, 20 A:
   1. Available Products: Subject to compliance with requirements, products that may be incorporated into the work include, but are not limited to the following:
      a. Cooper; 2221 (single pole), 2222 (two pole), 2223 (three way), 2224 (four way).
      b. Hubbell; CSI221 (single pole), CSI222 (two pole), CSI223 (three way), CSI224 (four way).
      c. Leviton; 1221-2 (single pole), 1222-2 (two pole), 1223-2 (three way), 12224-2 (four way).
      d. Pass & Seymour; 20AC1 (single pole), 20AC2 (two pole); 20AC3 (three way), 20AC4 (four way).

C. Pilot Light Switches, 20A:
   1. Available Products: Subject to compliance with requirements, products that may be incorporated into the work include, but are not limited to the following:
      a. Cooper; 2221PL for 120 V and 277V.
      b. Hubbell; HPL1221PL for 120 V and 277V.
      c. Leviton; 1221-PLR for 120 V, 1221-7PLR for 277V.
      d. Pass & Seymour; PS20AC1-PLR for 120 V.
   2. Description: Single pole, with neon-lighted handle, illuminated when switch is “OFF.”

2.5 WALL PLATES

A. Single and combination types to match corresponding wiring devices.
   1. Plate-Securing Screws: Stainless steel or unbreakable nylon in damp areas.
   2. Material: 0.035-inch-(1mm-) thick, satin-finished stainless steel.
   3. Provide in-use covers for all exterior installations and interior damp locations.
2.6 FINISHES

A. Color:
   1. Wiring Devices: As selected by Owner, unless otherwise indicated or required by NFPA 70 or device listing.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Comply with NECA 1, including the mounting heights listed in that standard, unless otherwise noted.

B. Coordination with Other Trades:
   1. Take steps to ensure 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.
   2. 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.
   3. 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.
   4. Install wiring devices after all wall preparation, including painting is complete.

C. Conductors:
   1. Do not strip insulation from conductors until just before they are spliced or terminated on devices.
   2. 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.
   3. The length of free conductors at outlets for devices shall meet provisions of NFPA 70, Article 300, without pigtails.
   4. Existing conductors:
      a. Cut back and pigtail or replace all damaged conductors.
      b. Straighten conductors that remain and remove corrosion and foreign matter.
      c. Pigtailing existing conductors is permitted provided the outlet box is large enough.

D. Device Installation:
   1. 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.
   2. Keep each wiring device in its package or otherwise protected until it is time to connect conductors.
   3. Do not remove surface protection such as plastic film and smudge covers until the last possible moment.
   4. Connect devices to branch circuits using pigtails that are not less than 6 inches (152 mm) in length.
   5. 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.
   6. Use a torque screwdriver when a torque is recommended or required by the manufacturer.
   7. When conductors larger than No. 12 AWG are installed on 15- or 20-A circuits, splice No. 12 AWG pigtails for device connections.
   8. Tighten unused terminal screws on the device.
   9. When mounting into metal boxes, remove the fiber or plastic washers used to hold device mounting screws in yokes, allowing metal-to-metal contact.

E. Receptacle Orientation:
1. Install ground pin of vertically mounted receptacles up, and on horizontally mounted receptacles to the right.

F. Device Plates: Do not use oversized or extra-deep plates. Repair wall finishes and remount outlet boxes when standard device plates do not fit flush or do not cover rough wall opening.

3.2 IDENTIFICATION

A. Comply with Division 26 Section “Identification for Electrical Systems.”
1. Receptacles: Identify panelboard and circuit number from which served. Use hot, stamped or engraved machine printing with black-filled lettering on face of plate, and durable wire markers or tags inside outlet boxes.

3.3 FIELD QUALITY CONTROL

A. Perform tests and inspections and prepare test reports.
1. Test Instruments: Use instruments that comply with UL 1436.
2. Test Instrument for Convenience Receptacles: digital wiring analyzer with digital readout or illuminated LED indicators of measurement.

B. Tests for Convenience Receptacles:
1. Line voltage: Acceptable range is 105 to 132V.
2. Percent Voltage Drop under 15-A Load: A value of 6 percent or higher is not acceptable.
3. Ground Impedance: Values of up to 2 ohms are acceptable.
4. GFCI Trip: Test for tripping values specified in UL 1436 and UL 943.
5. Using the test plug, verify that the device and its outlet box are securely mounted.
6. The tests shall be diagnostic, indicating damaged conductors, high resistance at the circuit breaker, poor connections, inadequate fault current path, defective devices, or similar problems. Correct circuit conditions, remove malfunctioning units and replace with new ones, and retest as specified above.

C. Test straight blade for the retention force of the grounding blade according to NFPA 99. Retention force shall be not less than 4 oz. (115g).

END OF SECTION
SECTION 26 05 15 - ELECTRIC MOTORS

PART 1 - GENERAL

1.1 SUMMARY

A. This section describes materials, installation and testing of induction motors and applies to motors which are generally provided as part of equipment specified in other sections. The Contractor shall provide motors, accessories and appurtenances complete and operable in accordance with the individual driven equipment specifications.

1.2 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Complete motor data shall be submitted, including:
   1. Machine name and specification number of driven machine.
   3. Motor type or model and dimensional drawing, including weight.
   4. Horsepower nominal.
   5. Guaranteed minimum full load efficiency. Also, nominal efficiencies at 1/2 and 3/4 load.
   6. Full load speed.
   7. Full load current at rated horsepower for application voltage.
   8. Service factor, minimum 1.15.
   9. Voltage, phase and frequency rating.
   10. Winding insulation class.
   11. Temperature rise class.
   12. Frame size.
   14. NEMA design.
   15. Thermal protection or over temperature protection.
   16. Wiring diagram for devices such as temperature switches, space heaters and motor leak detection as applicable.
   17. Bearing data, including recommendation of lubricants.
   18. Inverter duty motor for all motors connected to variable frequency drive controllers. Include minimum speed at which motors may be operated.
   19. Power factor at 1/2, 3/4 and full load.
   20. Complete nameplate data, rating and characteristics.
   21. Mounting arrangement, size and location of conduit entries, including lugs.
   22. Factory test results for each motor.

1.3 QUALITY ASSURANCE

A. Provide routine (short commercial) test data complying with NEMA MG 1-12.51 and MG 1-23.46.

B. Test thermally protected motors in accordance with NEMA MG 1 winding temperature and trip current tests.

C. Comply with NEMA MG 1.

D. Motors for applications in hazardous locations shall bear the UL label listing its use in accordance with the NEC.
1.4 COORDINATION

A. Furnish reviewed shop drawings from motor controller manufacturer for coordination and sizing of the controller.

B. Coordinate supplied motor connection box with conduits sizes indicated in the drawings.

C. Coordinate motor leads and lugs with wire sizes indicated in the drawings.

PART 2 - PRODUCTS

2.1 GENERAL MOTOR REQUIREMENTS

A. Unless otherwise specified or specifically required by the manufacturer of the equipment to be driven, all motors shall be single speed, squirrel cage, a-c induction type motors. Electric motors shall be NEMA Design B constant speed squirrel cage induction motors having normal starting torque with low starting current except for motors controlled by variable speed operation and other special motors. In no case shall starting torque or breakdown torque be less than the value specified in ANSI/NEMA MG 1. In all cases, motors shall be suitable for the indicated starting method.

B. Stator winding shall be copper.

C. The maximum motor loading of each motor shall not exceed its nameplate horsepower rating (exclusive of service factor) under any operating condition.

D. Motors shall be sized to start and accelerate the design loading and operate the full range of driven equipment without exceeding any of the specified design requirements. Motors that fail to meet these requirements shall be replaced at no additional cost to the Owner.

E. All three phase motors shall be provided with Class F insulation, rated to operate at a maximum ambient temperature of 40 degrees C and at the altitudes where the motors will be installed and operated without exceeding Class B temperature rise limits stated in ANSI/NEMA MG1-12, 42. Single phase motors shall have Class F insulation with temperature rise not to exceed the insulation class. Motors to be operated with variable frequency drives shall be provided with insulation systems to withstand 1600 volt spikes, with dV/dt as defined in NEMA MG 1-31.

F. All motors shall have a minimum service factor of 1.15.

G. Motors for use in hazardous locations shall have enclosures suitable for the classification of the location. Such motors shall be UL listed and stamped.

H. Motors larger than 50 HP located outdoors or in non-conditioned areas shall have 120-volt AC space heaters and temperature sensors.

I. For motors controlled by variable frequency drives, the critical vibration speed of the motor/load combination shall either not fall within the operating range of the drive or such frequencies shall be blocked with the drive critical speed avoidance circuit. All motors connected to variable frequency drives shall be inverter duty rated.

J. Unless otherwise specified, motors shall have no-load sound power levels not to exceed the values specified in NEMA MG 1-12.53.3.

K. Premium Efficiency Motors:
1. Motors with a nameplate rating of 1 horsepower and larger shall be premium efficiency type motors as determined by the testing set forth in ANSI/IEEE 112 – Standard Test Procedure for Polyphase Induction Motors and Generators, Method B. Motors shall be stamped with the efficiency on the nameplate with the caption “NEMA Nominal Efficiency.”

2. Efficiency index, nominal efficiency and minimum efficiency shall be defined in accordance with ANSI/NEMA MG1-12.59 – Efficiency Levels of Energy Efficient Polyphase Squirrel-Cage Induction Motors. All three values are required to be indicated in the submittal.

2.2 MOTOR BEARINGS

A. All motors greater than 2 horsepower shall have bearings designed for 17,500 hours (belted) or 100,000 hours (coupled) L-10 life.

B. Motors less than 2 horsepower shall be provided with sealed, permanently lubricated ball bearings.

C. Horizontal motors over 2 horsepower shall be shielded open-type bearing installed with labyrinth sealed end bells with pipe plugs. Bearings shall be regreasable and have provisions for purging old grease.

D. Vertical motors over 2 horsepower shall be provided with relubricatable ball, spherical, roller or plate type thrust bearings. Lubrication shall be per manufacturer’s recommendation for smooth operation and long life of the bearing. Drains shall be provided to prevent over lubrication.

2.3 MOTOR THERMAL PROTECTION

A. All single phase motors shall have integral thermal overload protection or shall be current limited.

B. Winding thermostats shall be provided in accordance with NEMA MG-1. Thermostats shall be snap action, bi-metallic, temperature actuated type switches and shall be provided with a normally closed contact. Thermostats shall be precalibrated by the manufacturer and shall be series connected.

2.4 ACCESSORIES

A. All vertical motors and horizontal motors 3 horsepower and larger shall have split-type conduit boxes with a gasketed moisture seal between the conduit box and motor frame. Motors less than 3 horsepower shall have the manufacturer’s standard conduit boxes. Motors other than open drip-proof shall be gasketed.

B. All motors weighing 250 pounds or greater shall have suitable lifting eyes for installation and removal.

C. Motor grounding lugs shall be provided and shall be suitable for terminating ground wires.

D. All motors shall be fitted with permanent stainless steel nameplates indelibly stamped or engraved with NEMA Standard motor data.

E. Refer to equipment specifications for special requirements such as space heaters or motor winding thermal protection.
PART 3 - EXECUTION

3.1 STORAGE

A. Protect motors from exposure to elements for which they are not designed. Install and energize temporary electrical service to motors with electrical heaters.

B. Store motors in an air-conditioned, ventilated or protected environment similar to or better than the destination environment.

3.2 INSTALLATION

A. Motor installation shall be performed in accordance with the motor manufacturer’s written recommendations and the written requirements of the manufacturer of the driven equipment.

B. Connections, switches, controls, disconnects and other items shall be provided in accordance with the plans and specifications for each motor.

C. The Contractor shall coordinate conduit sizes indicated in the drawings with the supplied motor connection box. The Contractor shall be responsible for providing larger connection boxes as may be required.

3.3 FIELD TESTING

A. Perform insulation resistance tests in accordance with NEMA MG-1. Test voltage shall be 1000 VAC plus twice the rated voltage of motor.

B. Inspect the physical and mechanical conditions of each motor installation including any deviations from the nameplate, drawings, specifications and manufacturer’s written guidelines. Verify expected rated voltage, phase and frequency for each motor installation. Confirm the presence of and correct application of lubrications for each motor along with proper securing and torque settings for bolted installations of each motor.

C. Check for proper phase and ground connections for each motor are connected. For multi-voltage motors, verify that motors are connected properly for the supplied voltage.

D. Verify that space heaters, where provided, are functional.

E. Test the motor for proper rotation prior to connection to the driven equipment. Measure and record running current and evaluate the current relative to the load conditions and nameplate full-load amps.

F. Simulate operating conditions for each motor to demonstrate proper operation of interlocks and control features.

G. Record operating current in each phase for each motor ½ horsepower and larger. Motors exceeding motor nameplates values shall be repaired or replaced.

H. For motors 50 horsepower and larger or when a discernible abnormal vibration is detectible, a vibration test shall be completed. Vibration shall not exceed 0.25 in./sec. For horizontal motors, the N-S and E-W vibrations shall be measured at the top and bottom of the front and rear bearing housing. For vertical motors, the N-S and E-W vibrations shall be measured at the upper and lower bearing housing.

I. All testing shall be witnessed by the Engineer and Owner.
1. Motor and Motor Protection Tests for motors – In addition to other testing start and stop each motor a minimum of 3 times and perform a run test for vibration, heat, and to document motor protection. The Contractor shall document the settings of the motor overcurrent protection, overload relay and similar data on the provided form – MOTOR TEST REPORT.

2. The Contractor shall develop non-conforming material reports for each failure and repair or report failures.

3. The Contractor shall replace defective parts, correct malfunctioning units, make all repairs and retest to demonstrate compliance. The Contractor shall document action taken on appropriate non-conforming material report.

3.4 MOTOR TEST REPORT

A. The following form is provided for the motor certification specified herein. Master blank forms are available on request.

END OF SECTION
MOTOR TEST REPORT

Each electric motor shall be tested for proper operation. Follow manufacturer's testing recommendations and procedures.

1. Name and Horsepower of Motor Tested: ____________________________

2. Overcurrent Protection: ____________________________

3. Overload Protection: ____________________________

4. Visual Inspection Checklist:
   - Momentarily Bump Motor Shaft for Proper Rotation
   - Motor Frame Bolts
   - Shaft Coupling
   - Lubricants
   - Other Comments:

5. Megger motor from wire in motor control center or control panel and record results:
   \[ \phi A-\phi B\quad \phi B-\phi C\quad \phi C-\phi A\]
   \[ \phi A-G\quad \phi B-G\quad \phi C-G\]

6. Record full load voltage and current:
   \[ V_{ab}\quad V_{an}\quad I_a\]
   \[ V_{bc}\quad V_{bn}\quad I_b\]
   \[ V_{ca}\quad V_{cn}\quad I_c\]

7. Motor Nameplate FLA: ______
   Running Amps: ______
   P.F. ______

8. Comments:

Signature Required: ____________________________

Company: ____________________________

Date: ____________________________
SECTION 26 05 19 - LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:
   1. Building wires and cables rated 600 V and less.
   2. Connectors, splices, and terminations rated 600 V and less.
   3. Sleeves and sleeve seals for cables.

B. Related Sections include the following:
   1. Division 26 Section

1.2 DEFINITIONS

A. EPDM: Ethylene-propylene-diene monomer rubber.

B. NBR: Acrylonitrile-butadiene rubber.

1.3 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Qualification Data: For testing agency.

A. Field quality-control test reports.

1.4 QUALITY ASSURANCE

A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association (NETA) or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.

1. Testing Agency’s Field Supervisor: Person currently certified by the InterNational Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. Comply with NFPA 70.

1.5 COORDINATION

A. Set sleeves in cast-in-place concrete, masonry walls, and other structural components as they are constructed.

PART 2 - PRODUCTS

2.1 CONDUCTORS AND CABLES

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
1. Alcan Products Corporation; Alcan Cable Division.
3. General Cable Corporation.
4. Senator Wire & Cable Company.
5. Southwire Company.

B. Copper Conductors: Comply with NEMA WC 70. No aluminum on project.

C. Conductor Insulation: Comply with NEMA WC 70 for Types THHN-THWN, XHHW and RHH-RHW-USE.

2.2 CONNECTORS AND SPLICES

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   1. AFC Cable Systems, Inc.
   3. O-Z/Gedney; EGS Electrical Group LLC.
   4. 3M; Electrical Products Division.
   5. Tyco Electronics Corp.

B. Description: Factory-fabricated connectors and splices of size, ampacity rating, material, type, and class for application and service indicated.

PART 3 - EXECUTION

3.1 CONDUCTOR MATERIAL APPLICATIONS

A. Feeders: Copper, stranded.

B. Branch Circuits: Copper. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.

3.2 CONDUCTOR INSULATION AND MULTICONDUCTOR CABLE APPLICATIONS AND WIRING METHODS

A. Service Entrance: Type RHH-RHW-USE single conductors in raceway.

B. Exposed Feeders: Type RHH-RHW-USE, single conductors in raceway.

C. Feeders Concealed in Ceilings, Walls, Partitions, and Crawlspace: Type RHH-RHW-USE, single conductors in raceway.

D. Feeders Concealed in Concrete, below Slabs-on-Grade, and Underground: Type RHH-RHW-USE single conductors in raceway.

E. Feeders in Cable Tray: Type RHH-RHW-USE, single conductors in raceway for larger than 4/0 AWG; Otherwise Type TC tray cable.

F. Exposed Branch Circuits, Including in Crawlspace: Type THHN-THWN, single conductors in raceway.

G. Branch Circuits Concealed in Ceilings, Walls, and Partitions: Type THHN-THWN, single conductors in raceway.
H. Branch Circuits Concealed in Concrete, below Slabs-on-Grade, and Underground: Type XHHW, single conductors in raceway.

I. Variable Frequency Drive Branch Circuits: Shielded cable, size adjusted for published ampacity of cable.

J. Cord Drops and Portable Appliance Connections: Type SO, hard service cord with stainless-steel, wire-mesh, strain relief device at terminations to suit application.

K. Class 1 Control Circuits: Type THHN-THWN, in raceway.

L. Class 2 Control Circuits: Type THHN-THWN, in raceway.

3.3 INSTALLATION OF CONDUCTORS AND CABLES

A. Conceal cables in finished walls, ceilings, and floors, unless otherwise indicated.

B. Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.

C. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage cables or raceway.

D. Install exposed cables parallel and perpendicular to surfaces of exposed structural members, and follow surface contours where possible.

E. Support cables according to Division 26 Section "Hangers and Supports for Electrical Systems."

F. Identify and color-code conductors and cables according to Division 26 Section "Identification for Electrical Systems."

3.4 CONNECTIONS

A. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

B. Make splices and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors.

C. Wiring at Outlets: Install conductor at each outlet, with at least 6 inches of slack.

D. Cable splicing, in general, will not be allowed. Where applicable, all wiring connections to be made using terminal block type connections. Wire nut use will permitted only where allowed by the Owner and Engineer.

3.5 FIELD QUALITY CONTROL

A. Perform tests and inspections and prepare test reports.
   1. Megger Test of individual conductors to ground after installation.
   2. Visual observation of conductor at accessible locations.

B. Tests and Inspections:
1. After installing conductors and cables and before electrical circuitry has been energized, test the following for compliance with requirements.
   a. All panel feeders.
   b. All motor feeders.
   c. All control wires for continuity.


C. Test Reports: Prepare a written report to record the following:
   1. Test procedures used.
   2. Test results that comply with requirements.
   3. Test results that do not comply with requirements and corrective action taken to achieve compliance with requirements.

D. Remove and replace malfunctioning units and retest as specified above.

END OF SECTION
SECTION 26 05 26 - GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes methods and materials for grounding systems and equipment.
   1. Underground distribution grounding.
   2. Common ground bonding with lightning protection system.

1.2 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Other Informational Submittals: Plans showing dimensioned as-built locations of grounding features specified in Part 3 “Field Quality Control” Article, including the following:
   1. Test wells.
   2. Ground rods.
   3. Ground rings.
   4. Grounding arrangements and connections for separately derived systems.

C. Field quality-control test reports.

D. Operation and Maintenance Data: For grounding to include the following in emergency, operation and maintenance manuals.
   1. Instructions for periodic testing and inspection of grounding features at test wells ground rings grounding connections for separately derived systems based on ANSI/NETA MTS.
      a. Test shall be to determine if ground resistance or impedance values remain within specified maximums and instructions shall recommend corrective action if they do not.
      b. Include recommended testing intervals.

1.3 QUALITY ASSURANCE

A. Electrical Components, Devices and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction and marked for intended use.

B. Comply with UL 467 for grounding and bonding materials and equipment.

PART 2 - PRODUCTS

2.1 CONDUCTORS

A. Insulated Conductors: Copper or tinned-copper wire or cable insulated for 600 V unless otherwise required by applicable Code or authorities having jurisdiction.

B. Bare copper Conductors:
   1. Solid Conductors: ASTM B3
   4. Bonding Conductor: No. 4 AWG, stranded conductor or per NFPA 70.
2.2 CONNECTORS

A. Listed and labeled by a nationally recognized testing laboratory acceptable to authorities having jurisdiction for applications in which used, and for specific types, and combinations of conductors and other items connected.

B. Bolted Connectors for Conductors and Pipes: Copper or copper alloy, bolted pressure-type, with at least two bolts.
   1. Pipe connectors: Clamp type, sized for pipe.

C. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.

2.3 GROUNDING ELECTRODES

A. Ground Rods: Copper-clad steel; 3/4 inch by 10 feet.

PART 3 - EXECUTION

3.1 APPLICATIONS

A. Conductors: Install solid conductor for No. 8 AWG and smaller, and stranded conductors for No. 6 AWG and larger, unless otherwise indicated.

B. Underground Grounding Conductors: Install bare tinned-copper conductor, No. 4/0 AWG minimum.
   1. Bury at least 30 inches below grade.

C. Conductor Terminations and Connections:
   1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.
   2. Underground Connections: Welded connectors except at test wells and as otherwise indicated.
   3. Connections to Ground Rods at Test Wells: Bolted connectors.
   4. Connections to Structural Steel: Bolted connectors.

3.2 GROUNDING UNDERGROUND DISTRIBUTION SYSTEM COMPONENTS

A. Comply with ANSI/IEEE C2 grounding requirements.

B. Grounding Manholes and Handholes: Install a driven ground rod through manhole or handhole floor, close to wall, and set rod depth so 4 inches will extend above finished floor. If necessary, install ground rod before manhole is placed and provide No. 1/0 AWG bare, tinned-copper conductor from ground rod into manhole through a waterproof sleeve in manhole wall. Protect ground rods passing through concrete floor with a double wrapping of pressure-sensitive insulating tape or heat-shrunk insulating sleeve from 2 inches above to 6 inches below concrete. Seal floor opening with waterproof, nonshrink grout.

C. Grounding Connections to Manhole and Handhole Components: Bond exposed-metal parts such as inserts, cable racks, pulling irons, ladders, and cable shields within each manhole or handhole, to ground rod or grounding conductor. Make connections with No. 4 AWG minimum, stranded, hard-drawn copper bonding conductor. Train conductors level or plumb around corners and fasten to manhole walls. Connect to cable armor and cable shields as recommended by manufacturer of splicing and termination kits.
D. Pad-Mounted Equipment: Install four ground rods and ground ring around the pad. Ground pad-mounted equipment and noncurrent-carrying metal items associated with utility transformers by connecting them to underground cable and grounding electrodes. Install tinned-copper conductor not less than No. 4/0 AWG for ground ring and for taps to equipment grounding terminals. Bury ground ring not less than 6 inches from the foundation.

3.3 EQUIPMENT GROUNDING

A. Install insulated equipment grounding conductors with all feeders and branch circuits.

B. Install insulated equipment grounding conductors with the following items, in addition to those required by NFPA 70:
   1. Feeders and branch circuits.
   2. Lighting circuits.
   3. Receptacle circuits.
   5. Three-phase motor and appliance branch circuits.
   6. Flexible raceway runs.

C. Air-Duct Equipment Circuits: Install insulated equipment grounding conductor to duct-mounted electrical devices operating at 120 V and more, including air cleaners, heaters, dampers, humidifiers and other duct electrical equipment. Bond conductor to each unit and to air duct and connected metallic piping.

D. Water Heater, Heat-Tracing and Antifrost Heating Cables: Install a separate insulated equipment grounding conductor to each electric water heater and heat-tracing cable. Bond conductor to heater units, piping, connected equipment and components.

E. Metal Poles Supporting Outdoor Lighting fixtures: Install grounding electrode and a separate insulated equipment grounding conductor in addition to grounding conductor installed with branch-circuit conductors.

3.4 INSTALLATION

A. Grounding Conductors: Route along shortest and straightest paths possible, unless otherwise indicated or required by Code. Avoid obstructing access or placing conductors where they may be subjected to strain, impact or damage.

B. Common Ground Bonding with Lightning Protection System: Comply with NFPA 780 and UL 96 when interconnecting with lightning protection system. Bond electrical power system ground directly to lightning protection system grounding conductor at closest point to electrical service grounding electrode. Use bonding conductor sized same as system grounding electrode conductor and install in conduit.

C. Ground rods: Drive rods until tops are 2 inches below finished floor or final grade, unless otherwise indicated.
   1. Interconnect ground rods with grounding electrode conductor below grade and as otherwise indicated. Make connections without exposing steel or damaging coating, if any.

D. Test Wells: Ground rod driven through drilled hole in bottom of handhole. Handholes are specified in Division 26 Section “Underground Ducts and Raceways for Electrical Systems,” and shall be at least 12 inches deep, with cover.
1. **Test Wells:** Install at least one test well for each service, unless otherwise indicated. Install at the ground rod electrically closest to service entrance. Set top of test well flush with finished grade or floor.

**E. Bonding Straps and Jumpers:** Install in locations accessible for inspection and maintenance, except where routed through short lengths of conduit.

1. **Bonding to Structure:** Bond straps directly to basic structure, taking care not to penetrate any adjacent parts.
2. **Bonding to Equipment Mounted on Vibration Isolation Hangers and Supports:** Install so vibration is not transmitted to rigidly mounted equipment.
3. **Use exothermic-welded connectors for outdoor locations, but if a disconnect-type connection is required, use a bolted clamp.**

**F. Grounding and Bonding for Piping:**

1. **Metal Water Service Pipe:** Install insulated copper grounding conductors, in conduit from building’s main service equipment, or grounding bus, to main metal water service entrance to building. Connect grounding conductors to main metal water service pipes, using a bolted clamp connector or by bolting a lug-type connector to a pipe flange, using one of the lug bolts of the flange. Where a dielectric main water fitting is installed, connect grounding conductor on street side of fitting. Bond metal grounding conductor conduit or sleeve to conductor at each end.
2. **Water Meter Piping:** Use braided-type bonding jumpers to electrically bypass water meters. Connect to pipe with a bolted connector.
3. **Bond each aboveground portion of gas piping system downstream from equipment shutoff valve.**

**G. Bonding Interior Metal Ducts:** Bond metal air ducts to equipment grounding conductors of associated fans, blowers, electric heaters and air cleaners. Install bonding jumper to bond across flexible duct connections to achieve continuity.

**H. Grounding for Steel Building Structure:** Install a driven ground rod at base of each corner column and at intermediate exterior columns at distances not more than 60 feet apart.

**I. Ground Ring:** Install a grounding conductor, electrically connected to each building structure ground rod and to each steel column and indicated item, extending around the perimeter of building.

1. **Install tinned-copper conductor not less than No. 4/0 AWG for ground ring and for taps to building steel.**
2. **Bury ground ring not less than 24 inches from building foundation at a depth not less than 30 inches below finished grade.**

**J. Ufer Ground (Concrete-Encased Grounding Electrode):** Fabricate according to NFPA 70, using a minimum of 20 feet of bare copper conductor not smaller than No. 4 AWG.

1. **If concrete foundation is less than 20 feet long, coil excess conductor within base of foundation.**
2. **Bond grounding conductor to reinforcing steel in at least four locations and to anchor bolts. Extend grounding conductor below grade and connect to building grounding grid or to grounding electrode external to concrete.**

### 3.5 FIELD QUALITY CONTROL

**A. Perform the following tests and inspections and prepare test reports:**

1. **After installing grounding system but before permanent electrical circuits have been energized, test for compliance with requirements.**
2. Test completed grounding system at each location where a maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal at ground test wells. Make tests at ground rods before any conductors are connected.
   a. Measure ground resistance not less than two full days after last trace of precipitation and without soil being moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance.
   b. Perform tests by fall-of-potential method according to IEEE 81.
3. Prepare dimensioned drawings locating each test well, ground rod and ground rod assembly and other grounding electrodes. Identify each by letter in alphabetical order, and key to the record of tests and observations. Include the number of rods driven and their depth at each location, and include observations of weather and other phenomena that may affect test results. Describe measures taken to improve test results.

B. Report measured ground resistances that exceed the following values:
   1. Power and Lighting Equipment or System with Capacity 500 kVA and Less: 10 ohms.
   2. Power and Lighting Equipment or System with Capacity 500 to 1000 kVA: 5 ohms.
   3. Power and Lighting Equipment or System with Capacity More Than 1000 kVA: 3 ohms.
   4. Power Distribution Units or Panelboards Serving Electronic Equipment: 3 ohm(s).

C. Excessive Ground Resistance: If resistance to ground exceeds specified values, notify Engineer promptly and include recommendations to reduce ground resistance.

END OF SECTION
SECTION 26 05 29 - HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:
   1. Hangers and supports for electrical equipment and systems.
   2. Construction requirements for concrete bases.

1.2 DEFINITIONS

A. RMC: Rigid metal conduit.


1.3 PERFORMANCE REQUIREMENTS

A. Design supports for multiple raceways capable of supporting combined weight of supported systems and its contents.

B. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

1.4 SUBMITTALS

A. Product Data: For the following:
   1. Steel slotted support systems.

B. Shop Drawings: Show fabrication and installation details and include calculations for the following:
   1. Trapeze hangers. Include Product Data for components.
   2. Steel slotted channel systems. Include Product Data for components.
   3. Equipment supports.

1.5 QUALITY ASSURANCE

A. Comply with NFPA 70.

1.6 COORDINATION

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases.

PART 2 - PRODUCTS

2.1 SUPPORT, ANCHORAGE AND ATTACHMENT COMPONENTS

A. Steel Slotted Support Systems: Comply with MFMA-4, factory-fabricated components for field assembly.
   1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the work include, but are not limited to the following:
      a. Allied Tube & Conduit.
      b. Cooper B-Line, Inc.; a division of cooper Industries.
      c. ERICO International Corporation
2. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.
3. Nonmetallic Coatings: Manufacturer’s standard PVC, polyurethane, or polyester coating applied according to MFMA-4.
4. Channel Dimensions: Selected for applicable load criteria.

B. Raceway and Cable Supports: As described in NECA 1 and NECA 101. NECA publications are available at www.NECAnet.org.

C. Conduit and Cable Support Devices: Steel hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.

D. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for non-armored electrical conductors or cables in riser conduits. Plugs shall have number, size and shape of conductor gripping pieces as required to suit individual conductors or cables supported.

E. Structural Steel for Fabricated Supports and Restraints: ASTM A 36/A 36M, steel plates, shapes and bars.

F. Mounting, Anchoring and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:
1. Powder-Actuated Fasteners: Threaded 304 stainless steel stud, for use in hardened Portland cement concrete, steel or wood, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.
   a. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the work include, but are not limited to, the following:
      1). Hilti Inc.
      2). ITW Ramset/Red Head; a division of Illinois tool works, Inc.
      3). MKT Fastening, LLC
2. Mechanical-Expansion Anchors: Insert-wedge-type, stainless steel, for use in hardened Portland cement concrete with tension, shear and pullout capacities appropriate for supported loads and building materials in which used.
   a. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the work include, but are not limited to, the following:
      1). Cooper B-Line, Inc.; a division of Cooper Industries
      2). Empire Tool and Manufacturing Co., Inc.
      3). Hilti Inc.
      4). ITW Ramset/Red head; a division of Illinois tool works, Inc.
      5). MKT Fastening, LLC.
3. Concrete Inserts: Stainless steel, slotted support system units similar to MSS Type 18; complying with MFMA-4 or MSS SP-58.
4. Clamps for Attachment to Steel Structural Elements: MSS SP-58, type suitable for attached structural element.
5. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM F 3125.
6. Toggle bolts: All-steel springhead type.
8. Nuts: Match threaded rod or bolt; double nut vertical hanger rods.
2.2 FABRICATED METAL EQUIPMENT SUPPORT ASSEMBLIES.

A. Description: bolted, structural-steel shapes, shop or field fabricated to fit dimensions of supported equipment.

PART 3 - EXECUTION

3.1 APPLICATION

A. Comply with NECA 1 and NECA 101 for application of hangers and supports for electrical equipment and systems except if requirements in this Section are stricter.

B. Outdoor locations: Supporting material shall be stainless steel or PVC-Coated galvanized steel or as described within the Drawings.

C. Indoor locations: Supporting materials shall be galvanized in dry areas and stainless steel or PVC-Coated galvanized steel in damp areas, or as described within the Drawings.

D. Maximum Support Spacing and Minimum Hanger Rod Size for Raceway: Space supports for RMC as required by NFPA 70. Minimum rod size shall be ¼ inch in diameter.

E. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted support system, sized so capacity can be increased by at least 25 percent in future without exceeding specified design load limits.
   1. Secure raceways and cables to these supports with two-bolt conduit clamps.

3.2 SUPPORT INSTALLATION

A. Comply with NECA 1 and NECA 101 for installation requirements except as specified in this Article.

B. Raceway Support Methods: In addition to methods described in NECA 1, RMC may be supported by openings through structure members, as permitted in NFPA 70.

C. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lbs.

D. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated by code:
   1. To Wood: Fasten with lag screws or through bolts.
   2. To New Concrete: Bolt to concrete inserts.
   3. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
   4. To Existing Concrete: Expansion anchor fasteners.
   5. Instead of expansion anchors, powder-actuated driven threaded studs provided with lock washers and nuts may be used in existing standard-weight concrete 4 inches thick or greater. Do not use for anchorage to lightweight-aggregate concrete or for slabs less than 4 inches thick.
   6. To Steel: Welded threaded studs complying with AWS D1.1/D1.1M, with lock washers and nuts.
   7. To Light Steel: Stainless steel sheet metal screws.
8. Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers and other devices on slotted-channel racks attached to substrate.

E. Drill holes for expansion anchors in concrete at locations and to depths that avoid reinforcing bars.

3.3 INSTALLATION OF FABRICATED METAL SUPPORTS

A. Cut, fit and place miscellaneous metal supports accurately in location, alignment and elevation to support and anchor electrical materials and equipment.

3.4 CONCRETE BASES

A. Construct concrete bases of dimensions indicated but not less than 4 inches larger in both directions than supported unit, and so anchors will be a minimum of 10 bolt diameters from edge of the base.

B. Use 3000 psi, 28-day compressive-strength concrete.

C. Anchor equipment to concrete base.
   1. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions and directions furnished with items to be embedded.
   2. Install anchor bolts to elevations required for proper attachment to supported equipment.
   3. Install anchor bolts according to anchor-bolt manufacturer's written instructions.

END OF SECTION
SECTION - 26 05 33 - RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes raceways, fittings, boxes, enclosures, and cabinets for electrical wiring.

B. Related Sections include the following:
   1. Division 26 Section "Underground Ducts and Raceways for Electrical Systems" for exterior ductbanks, manholes, and underground utility construction.
   2. Division 26 Section “PVC Coated Conduit.”

1.2 DEFINITIONS

A. LFMC: Liquidtight flexible metal conduit.

B. LFNC: Liquidtight flexible nonmetallic conduit.

C. GRS: Galvanized Rigid Steel Conduit.

D. RNC: Rigid nonmetallic conduit.

E. EMT: Electrical Metallic Tubing.

1.3 SUBMITTALS

A. Product Data: for surface raceways, wireways and fittings, hinged-cover enclosures and cabinets.

B. Custom enclosures and cabinets.

C. Source quality-control test reports.

1.4 QUALITY ASSURANCE

A. Electrical Components, Devices and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. Comply with NFPA 70.

PART 2 - PRODUCTS

2.1 METAL CONDUIT AND TUBING

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
   1. AFC Cable Systems, Inc.
   2. Alflex Inc.
   3. Allied Tube & Conduit; a Tyco International Ltd. Co.
   4. Anamet Electrical, Inc.; Anaconda Metal Hose.
   5. Electri-Flex Co.
   7. Maverick Tube Corporation.

B. Rigid Steel Conduit: ANSI C80.1.

C. PVC-Coated Steel Conduit: PVC-coated.
   1. Comply with NEMA RN 1.
   2. Coating Thickness: 0.040 inch, minimum.
   3. Comply with ETL Verified PVC-001.

D. Joint Compound for Rigid Steel Conduit: Listed for use in cable connector assemblies and compounded for use to lubricate and protect threaded raceway joints from corrosion and enhance their conductivity.

2.2 NONMETALLIC CONDUIT AND TUBING

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
   1. AFC Cable Systems, Inc.
   2. Anamet Electrical, Inc.; Anaconda Metal Hose.
   3. Arnco Corporation
   4. CANTEX Inc.
   5. CertainTeed Corp.; Pipe & Plastics Group
   7. ElecSYS, Inc.
   8. Electri-Flex co.
   9. Lamson & Sessions; Carlon Electrical Products.
   10. Manhattan/CDT/Cole-Flex.
   11. RACO; a Hubbell Company
   12. Thomas & Betts Corporation.

B. RNC: NEMA TC2, Type EPC-40-PVC, unless otherwise indicated.

C. Fittings for RNC: NEMA TC 3; match to conduit or tubing type and material.

2.3 BOXES, ENCLOSURES, AND CABINETS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
   1. Cooper Crouse-Hinds; Div. of Cooper Industries, Inc.
   2. EGS/Appleton Electric.
   3. Erickson Electrical Equipment Company
   5. Hubbell Incorporated; Killark Electric Manufacturing Co. Division
   7. RACO; a Hubbell company.
   8. Scott Fetzer Co.; Adalet Division.
   9. Spring City Electrical Manufacturing Company.
   10. Stahlin Non-Metallic Enclosures.
   12. Walker Systems, Inc.; Wiremold Company (The)

B. Sheet Metal Outlet and Device boxes: NEMA OS 1.
C. Cast-Metal Outlet and Device boxes: NEMA FB 1, Type FD, with gasketed cover.

D. Small Sheet Metal Pull and Junction boxes: NEMA OS 1.

E. Cast-Metal Access, Pull and Junction boxes: NEMA FB 1.

F. Hinged-Cover Enclosures: NEMA 250, Type 1, with continuous-hinge cover with flush latch for conditioned spaces only, unless otherwise indicated.

G. Hinged-Cover Enclosures: NEMA 250, Type 4 Stainless steel, with continuous-hinge cover with latches for outdoor, process buildings, above and below grade structures and damp locations, unless otherwise indicated.

2.4 SLEEVES FOR RACEWAYS

A. Steel Pipe Sleeves: ASTM A 53/A, 53M, Type E, Grade B, Schedule 40, galvanized steel, plain ends.

B. Cast-Iron Pipe Sleeves: Cast or fabricated “wall pipe,” equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.

C. Sleeves for Rectangular Openings: Galvanized sheet steel with minimum 0.052- or 0.138-inch thickness as indicated and of length to suit application.

D. Coordinate sleeve selection and application with Engineer.

2.5 SLEEVE SEALS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   1. Advance Products & systems, Inc.
   2. Calpico, Inc.
   3. Metraflex Co.
   4. Pipeline Seal and Insulator, Inc.

B. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and cable.
   1. Sealing Elements: EPDM interlocking links shaped to fit surface of cable or conduit. Include type and number required for material and size of raceway or cable.
   2. Pressure Plates: Stainless steel. Include two for each sealing element.
   3. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements. Include one for each sealing element.

PART 3 - EXECUTION

3.1 RACEWAY APPLICATION

A. Outdoors: apply raceway products as specified below, unless otherwise indicated:
   1. Exposed: PVC-Coated Rigid Steel
   2. Concealed: PVC-Coated Rigid Steel.
   4. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC.

B. Indoors:
   1. Exposed: Galvanized Rigid Steel or as noted in the Drawings.
2. Concealed: Galvanized Rigid Steel or as noted in the Drawings.
3. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid or Motor-Driven Equipment): LFMC.
4. Damp or Wet Locations: PVC-coated Rigid Steel or as noted in the Drawings.

C. Minimum Raceway Size: ¾-inch trade size; 1-inch trade size for below grade installation.

D. Raceway Fittings: Compatible with raceways and suitable for use and location.
   1. Rigid Steel Conduit: Use threaded rigid steel conduit fittings, unless otherwise indicated.
   2. PVC Externally Coated, Rigid Steel Conduits: Use only fittings listed for use with that material.

3.2 INSTALLATION

A. Comply with NECA 1 for installation requirements applicable to products specified in Part 2 except where requirements on Drawings or in this Article are stricter.

B. Keep raceways at least 6 inches away from parallel runs of flues and steam or hot-water pipes. Install horizontal raceway runs above water and steam piping.

C. Complete raceway installation before starting conductor installation.

D. Support raceways as specified in Division 26 Section “Hangers and Supports for Electrical Systems.”

E. Arrange stub-ups so curved portions of bends are not visible above the finished slab.

F. Install no more than the equivalent of four 90-degree bends in any conduit run except for communications conduits, for which fewer bends are allowed.

G. Raceways Embedded in Slabs:
   1. Run conduit larger than 1 inch trade size, parallel or at right angles to main reinforcement. Where at right angles to reinforcement, place conduit close to slab support.
   2. Arrange raceways to cross building expansion joints at right angles with expansion fittings.
   3. Do not install conduits in such a manner as to compromise the structural integrity of walls, roofs, ceilings or floor. Where necessary, provide additional supporting members to support conduit runs. Below grade conduits 1 1/2” and larger shall be routed 24” below the concrete floor slabs.
   4. Comply with Chapter 6 of ACI 318.
   5. Change from nonmetallic conduit to Galvanized Rigid Steel or PVC-Coated Rigid Steel Conduit before rising above the floor.

H. Threaded Conduit Joints, Exposed to Wet, Damp, Corrosive, or Outdoor Conditions: Apply listed compound to threads of raceway and fittings before making up joints. Follow compound manufacturer’s written instructions.

I. Raceway Terminations at Locations Subject to Moisture or Vibration: Use insulating bushings to protect conductors, including conductors smaller than No. 4 AWG.

J. Install pull wires in empty raceways. Use polypropylene or monofilament plastic line with not less than 200-lb tensile strength. Leave at least 12 inches of slack at each end of pull wire.
K. Install raceway sealing fittings at suitable, approved and accessible locations and fill them with listed sealing compound. For concealed raceways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install raceway sealing fittings at the following points:
1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
2. Where otherwise required by NFPA 70.

L. Expansion-Joint Fittings: Install in each run of aboveground conduit that is located where environmental temperature change may exceed 30 deg. F, and that has straight-run length that exceeds 25 feet.
1. Install expansion-joint fittings for each of the following locations, and provide type and quantity of fittings that accommodate temperature change listed for location:
   a. Outdoor Locations Not Exposed to Direct Sunlight: 125 deg F temperature change.
   b. Outdoor Locations Exposed to Direct Sunlight: 155 deg F temperature change.
   c. Indoor Spaces: connected with the Outdoors without Physical Separation: 125 deg F temperature change.
   d. Attics: 135 deg F temperature change.
2. Install fitting(s) that provide expansion and contraction for at least 0.00041 inch per foot of length of straight run per deg F of temperature change.
3. Install each expansion-joint fitting with position, mounting and piston setting selected according to manufacturer’s written instructions for conditions at specific location at the time of installation.

M. Flexible conduit connections: Use maximum of 36 inches of flexible conduit for equipment subject to vibration, noise transmission, or movement, and for transformers and motors.
1. Use LFMC in damp or wet locations subject to severe physical damage.
2. Use LFMC or LFNC in damp or wet locations not subject to severe physical damage.

N. Recessed Boxes in Masonry Walls: Saw-cut opening for box in center of cell of masonry block, and install box flush with surface of wall.

3.3 SLEEVE INSTALLATION FOR ELECTRICAL PENETRATIONS

A. Coordinate sleeve selection and application Engineer.

B. Concrete Slabs and Walls: Install sleeves for penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of slabs and walls.

C. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.

D. Fire-Rated Assemblies: Install sleeves for penetrations of fire-rated floor and wall assemblies unless openings compatible with firestop system used are fabricated during construction of floor or wall.

E. Cut sleeves to length for mounting flush with both surfaces of walls.

F. Size pipe sleeves to provide ¼-inch annular clear space between sleeve and raceway unless sleeve seal is to be installed.

G. Seal space outside of sleeves with grout for penetrations of concrete and masonry.

H. Interior Penetrations of Non-Fire-Rated Walls and Floors: Seal annular space between sleeve and raceway, using joint sealant appropriate for size, depth, and location of joint.
I. Fire-Rated-Assembly Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at raceway penetrations. Install sleeves and seal with fire-stop materials.

J. Roof-Penetration Sleeves: Seal penetration of individual raceways with flexible, boot-type flashing units applied in coordination with roofing work.

K. Aboveground, Exterior-Wall Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.

L. Underground, Exterior-Wall Penetrations: Install cast-iron “wall pipes” for sleeves. Size sleeves to allow for 1-inch annular clear space between raceway and sleeve for installing mechanical sleeve seals.

3.4 SLEEVE-SEAL INSTALLATION

A. Install to seal underground, exterior wall penetrations.

B. Use type and number of sealing elements recommended by manufacturer for raceway material and size. Position raceway in center of sleeve. Assemble mechanical sleeve seals and install in annular space between raceway and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.5 FIRESTOPPING

A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly.

3.6 PROTECTION

A. Provide final protection and maintain conditions that ensure coatings, finishes and cabinets are without damage or deterioration at time of Substantial Completion.

END OF SECTION
SECTION 26 05 33.13 - PVC COATED CONDUIT

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes PVC-coated raceways, fittings, boxes, enclosures, and cabinets for electrical wiring.

B. Related Sections include the following:
   1. Division 26 Section “Raceway and Boxes for Electrical Systems”.

1.2 SUBMITTALS

A. Product Data: for surface raceways, wireways and fittings, hinged-cover enclosures and cabinets.

B. Custom enclosures and cabinets.

C. Source quality-control test reports.

1.3 QUALITY ASSURANCE

A. Electrical Components, Devices and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. Comply with NFPA 70.

C. All the conduit, fittings, and supporting products shall be provided by the same manufacturer to ensure that a five-year product warrantee is achieved.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include:
   1. Perma-Cote
   2. Plasti-Bond
   3. KorKap

2.2 MATERIALS

A. PVC-coated, Galvanized Rigid Conduit (GRC) and fittings shall meet all the performance standards specified herein and such performance standards shall require verification by a nationally recognized testing agency including American Society for Testing and Materials (ASTM) and Underwriter Laboratories (UL).

B. The PVC coated galvanized rigid conduit shall be UL Listed. The PVC coating shall have been investigated by UL as providing the primary corrosion protection for the rigid metal conduit. Ferrous fittings for general service locations shall be UL Listed with PVC as the primary corrosion protection. Hazardous location fittings, prior to plastic coating shall be UL listed. All conduits and fittings must be new, unused material. Applicable UL standards shall include: UL 6 Standard for Safety, Rigid Metal Conduit, UL514B Standard for Safety, Fittings for Conduit and Outlet Boxes.
C. The PVC coated galvanized rigid conduit shall be Electrical Testing Laboratory (ETL) Verified to the Intertek ETL SEMKO High Temperature H:O PVC Coating Adhesion Test Procedure for 200 hours. The PVC coated galvanized rigid conduit shall bear the ETL Verified PVC-001 label to signify compliance to the adhesion performance standard.

D. The conduit shall be hot dip galvanized inside and out with hot galvanized threads.

E. A PVC sleeve extending one pipe diameter or two inches, whichever is less, shall be formed at every female fitting opening except unions. The inside sleeve diameter shall be matched to the outside diameter of the conduit.

F. The PVC coating on the outside of conduit couplings shall have a series of longitudinal ribs 40 mils in thickness to protect the coating from tool damage during installation.

G. Form 8 Condulets, 1/2” through 2” diameters, shall have a v-seal tongue-in-groove gasket to effectively seal against the elements. The design shall be equipped with a positive placement feature to ease and assure proper installation. Certified results confirming seal performance at 15 psig (positive) and 25 in. of mercury (vacuum) for 72 hours shall be available. Form 8 Condulets shall be supplied with plastic encapsulated stainless steel cover screws.

H. A urethane coating shall be uniformly and consistently applied to the interior of all conduit and fittings. This internal coating shall be a nominal 2 mil thickness. Conduit or fittings having areas with thin or no coating shall be unacceptable.

I. The PVC exterior and urethane interior coatings applied to the conduit shall afford sufficient flexibility to permit field bending without cracking or flaking at temperatures above 30°F (-1°C).

J. All male threads on conduit, elbows and nipples shall be protected by application of a urethane coating.

K. All female threads on fittings or conduit couplings shall be protected by application of a urethane coating.

L. Independent certified test results shall be available to confirm coating adhesion under the following conditions:
   1. Conduit and condulet exposure to 150°F (65°C) and 95% relative humidity with a minimum mean time to failure of 30 days (ASTM D1151).
   2. The interior coating bond shall be confirmed using the Standard Method of Adhesion by Tape Test (ASTM D3359).
   3. No trace of the internal coating shall be visible on a white cloth following six wipes over the coating which has been wetted with acetone (ASTM D1308).
   4. The exterior coating bond shall be confirmed using the methods described in Section 3.8, NEMA RN1. After these tests the physical properties of the exterior coating shall exceed the minimum requirements specified in Table 3.1, NEMA RN1.

M. Right angle beam clamps and U bolts shall be specially formed and sized to snugly fit the outside diameter of the coated conduit. All U bolts will be supplied with plastic encapsulated nuts that cover the exposed portions of the threads.

**PART 3 - EXECUTION**

3.1 **INSTALLATION**

A. All clamping, cutting, threading, bending, and assembly instructions listed in the manufacturer's installation guide should be vigorously followed.
B. Installation of the PVC Coated Conduit System shall be performed in accordance with the Manufacturer's Installation Manual. To assure correct installation, the installer shall be certified by Manufacturer to install coated conduit.

C. Installer certification, before installation, is required.

D. Clamps, bolts, angles, pipe straps, struts, rods, nuts and other supporting products for PVC-coated conduits shall be PVC-coated or stainless steel.

E. The Contractor shall use equipment specifically designed for PVC-coated conduit when cutting, clamping, reaming, threading, bending, assembling or performing other installation procedures. PVC-coating shall be protected.

F. Touch-up compound for PVC-coated conduit shall not be allowed. All conduits with damaged coatings shall be removed and replaced at no cost to owner.

END OF SECTION
SECTION 26 05 43 - UNDERGROUND DUCTS AND RACEWAYS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:
   1. Conduit, ducts and duct accessories for concrete-encased duct banks.
   2. Handholes and boxes.

1.2 DEFINITIONS

A. RNC: Rigid nonmetallic conduit.

B. SCTE: Society of Cable Telecommunications Engineers.

1.3 SUBMITTALS

A. Product Data: For the following:
   1. Accessories for manholes, handholes, boxes.

B. Shop Drawings for Precast or Factory-Fabricated Underground Utility Structures: Include plans, elevations, sections, details, attachments to other work, and accessories, including the following:
   1. Duct entry provisions, including locations and duct sizes.
   2. Reinforcement details/
   3. Step details.
   5. Dimensioned locations of cable rack inserts, pulling-in and lifting irons, and sumps.

C. Shop Drawings for Factory-Fabricated Handholes and Boxes Other Than Precast Concrete: Include dimensioned plans, sections and elevations, and fabrication and installation details, including the following:
   1. Duct entry provisions, including locations and duct sizes.
   2. Cover design.
   4. Dimensioned locations of cable rack inserts and pulling-in lifting irons.

D. Duct-Bank Coordination Drawings: Show duct profiles and coordination with other utilities and underground structures.
   1. Include plans and sections, drawn to scale, and show bends and locations of expansion fittings.

E. Product Certificates: for concrete and steel used in precast concrete handholes, as required by ASTM C858.

F. Source quality-control test reports.

G. Field quality-control test reports.

1.4 QUALITY ASSURANCE

A. Comply with ANSI C2.
B. Comply with NFPA 70.

1.5 DELIVERY, STORAGE AND HANDLING

A. Deliver ducts to Project site with ends capped. Store nonmetallic ducts with supports to prevent bending, warping, and deforming.

B. Store precast concrete and other factory-fabricated underground utility structures at Project site as recommended by manufacturer to prevent physical damage. Arrange so identification markings are visible.

C. Lift and support precast concrete units only at designated lifting or supporting points.

1.6 COORDINATION

A. Coordinate layout and installation of ducts, manholes, handholes, and boxes with final arrangement of other utilities, site grading, and surface features as determined in the field.

B. Coordinate elevations of ducts and duct-bank entrances into manholes, handholes and boxes with final arrangement of other utilities, site grading, and surface features as determined in the field.

C. Coordinate elevations of ducts and duct-bank entrances into manholes, handholes, and boxes with final locations and profiles of ducts and duct banks as determined by coordination with other utilities, underground obstructions and surface features. Revise locations and elevations from those indicated a required to suit field conditions and to ensure that duct runs drain to manholes and handholes and as approved by Engineer.

PART 2 - PRODUCTS

2.1 CONDUIT

A. Rigid Steel conduit: Galvanized. Comply with ANSI C80.1.

B. PVC-Coated Steel Conduit: Comply with ANSI C80.

C. RNC: NEMA TC2, type EPPC-40-PVC, UL 651 , with matching fittings by same manufacturer as the conduit, complying with NEMA TC 3 and UL 514B.

2.2 PRECAST CONCRETE HANDHOLES AND BOXES

A. Available Manufacturers: subject to compliance with requirements, manufacturers offering products that may be incorporated into the work include, but are not limited to, the following:

1. Oldcastle Precast Group.

B. Comply with ASTM C 858 for design and manufacturing processes.

C. Description: Factory-fabricated, reinforced-concrete, monolithically poured walls and bottom unless open-bottom enclosure are indicated. Frame and cover shall form top of enclosure and shall have load rating consistent with that of handhole or box.

1. Frame and Cover: Weatherproof cast-iron frame, with cast-iron cover with recessed cover hook eyes and tamper-resistant, captive, cover-securing bolts.

2. Frame and Cover: Weatherproof steel frame, with steel cover with recessed cover hook eyes and tamper-resistant, captive cover-securing bolts.
3. Frame and Cover: Weatherproof steel frame, with hinged steel access door assembly with tamper-resistant, captive, cover-securing bolts.
4. Frame and cover: Weatherproof aluminum frame with hinged aluminum access door assembly with tamper-resistant, captive, cover-securing bolts.
   a. Cover Hinges: concealed, with hold-open ratchet assembly.
   b. Cover Handle: Recessed.
5. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
6. Cover Legend: Molded lettering, "ELECTRIC."
7. Configuration: Units shall be designed for flush burial and have integral closed bottom, unless otherwise indicated.
8. Extensions and Slabs: Designed to mate with bottom of enclosure. Same material as enclosure.
   a. Extension shall provide increased depth of 12 inches.
   b. Slab: Same dimensions as bottom of enclosure, and arranged to provide closure.
9. Windows: Precast openings in walls, arranged to match dimensions and elevations of approaching ducts and duct banks plus an additional 12 inches vertically and horizontally to accommodate alignment variations.
   a. Windows shall be located no less than 6 inches from interior surfaces of walls, floors, or frames and covers of handholes, but close enough to corners to facilitate racking of cables on walls.
   b. Window opening shall have cast-in-place, welded wire fabric reinforcement for field cutting and bending to tie in to concrete envelopes of duct banks.
   c. Window openings shall be framed with at least two additional No. 4 steel reinforcing bars in concrete around each opening.
10. Duct Entrances in Handhole Walls: Cast end-bell or duct-terminating fitting in wall for each entering duct.
    a. Type and size shall match fittings to duct or conduit to be terminated.
    b. Fittings shall align with elevations of approaching ducts and be located near interior corners of handholes to facilitate racking of cable.
11. Handholes 12 inches wide by 24 inches long and larger shall have inserts for cable racks and pulling-in irons installed before concrete is poured.

2.3 HANDHOLES AND BOXES OTHER THAN PRECAST CONCRETE

A. Description: comply with SCTE 77.
   2. Configuration: Units shall be designed for flush burial and have integral closed bottom, unless otherwise indicated.
   3. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure.
   4. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
   5. Cover Legend: Molded lettering, "ELECTRIC" or as noted.
   7. Handholes 12 inches wide by 24 inches long and larger shall have factory-installed inserts for cable racks and pulling-in irons.

B. Polymer Concrete Handholes and Boxes with Polymer Concrete Cover: Molded of sand and aggregate, bound together with a polymer resin and reinforced with steel or fiberglass or a combination of the two.
   1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the work include, but are not limited to the following:
      a. Amorcast Products Company.
      b. Quazite
      c. Carson Industries LLC.
2.4 UTILITY STRUCTURE ACCESSORIES

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the work include, but are not limited to the following:
   1. Bilco Company (The).
   2. Campbell Foundry Company.
   3. Carder Concrete Products
   4. Christy Concrete Products.
   5. East Jordan Iron Works, Inc.
   7. McKinley Iron Works, Inc.
  13. Riverton Concrete Products; a division of Cretex companies, Inc.
  14. Strongwell Corporation; Lenoir City Divison.
  15. Underground Devices, Inc.
  16. Utility Concrete Products, LLC.
  17. Utility Vault Co.
  18. Wausau Tile, Inc.

B. Duct-Sealing Compound: Nonhardening, safe for contact with human skin, not deleterious to cable insulation and workable at temperatures as low as 35 degrees F. Capable of withstanding temperature of 300 degrees F without slump and adhering to clean surfaces of plastic ducts, metallic conduits, conduit coatings, concrete, masonry, lead, cable sheaths, cable jackets, insulation materials, and common metals.

C. Cover Hooks: Heavy duty, designed for lifts 60 Lb and greater.

PART 3 - EXECUTION

3.1 UNDERGROUND DUCT APPLICATION

A. Ducts for Electrical Feeders 600 V and Less: RNC, NEMA Type EPC-40-PVC, in red blended mix concrete-encased duct bank, unless otherwise indicated. Transition to above ground shall be PVC-coated steel conduit.

3.2 UNDERGROUND ENCLOSURE APPLICATION

A. Handholes and boxes for 600 V and Less:
   1. Units in Roadways and Other Deliberate Traffic Paths: Precast concrete. AASHTO HB 17, H-20 structural load rating.
   2. Units in Driveway, Parking Lot, and Off-Roadway Locations, Subject to Occasional, Nondeliberate Loading by Heavy Vehicles: Precast concrete, AASHTO HB 17, H-20 structural load rating.

3.3 EARTHWORK

A. Restore surface features at areas disturbed by excavation and reestablish original grades, unless otherwise indicated. Replace removed sod immediately after backfilling is completed.
B. Restore areas disturbed by trenching, storing of dirt, cable laying, and other work. Restore vegetation and include necessary top soil ing, fertilizing, timing, seeding, sodding, sprigging and mulching.

C. Cut and patch existing pavement in the path of underground ducts and utility structures.

3.4 DUCT INSTALLATION

A. Slope: Pitch ducts a minimum slope of 1:300 down toward manholes and handholes and away from buildings and equipment. Slope ducts from high point in runs between two manholes to drain in both directions.

B. Curves and Bends: Use 5-degree angle couplings for small changes in direction. Use manufactured long sweep bends with a minimum radius of 36 inches, both horizontally and vertically unless otherwise indicated. All below grade elbows and bends to be galvanized.

C. Joints: Use solvent-cemented joints in ducts and fittings and make watertight according to manufacturer’s written instructions. Stagger couplings so those of adjacent ducts do not lie in same plane.

D. Duct Entrances to Manholes and Concrete and Polymer Concrete Handholes: Use end bells, spaced approximately 10 inches o.c. for 5-inch ducts and vary proportionately for other duct sizes.
   1. Begin change from regular spacing to end-bell spacing 10- feet from the end bell without reducing duct line slope and without forming a trap in the line.
   2. Grout end bells into structure walls from both sides to provide watertight entrances.

E. Building Wall or Floor Penetrations: Make a transition from underground duct to PVC coated rigid steel conduit unless otherwise indicated, at least 5 feet outside the building wall without reducing duct line slope away from the building and without forming a trap in the line. Use fittings manufactured for duct-to-conduit transition.

F. Sealing: Provide temporary closures at terminations of ducts that have cables pulled. Seal spare ducts at terminations. Use sealing compound and plugs to withstand at least 15-psig hydrostatic pressure.

G. Pulling cord: Install 100-lbf-test nylon cord in ducts, including spares.

3.5 INSTALLATION OF CONCRETE MANHOLES, HANDHOLES AND BOXES

A. Precast Concrete Handhole and Manhole Installation:
   1. Comply with ASTM C 891, unless otherwise indicated.
   2. Install units level and plumb and with orientation and depth coordinated with connecting ducts to minimize bends and deflections required for proper entrances.
   3. Unless otherwise indicated, support units on a level 12” bed of crushed stone or gravel graded from 1-inch sieve to No. 4 sieve and compacted to same density as adjacent undisturbed earth.

B. Elevations:
   1. Install handholes with bottom below the frost line.
   2. Handhole covers: In paved areas and trafficways, set surface flush with finished grade. Set covers of other handholes 1 inch above finished grade.
   3. Where indicated, cast handhole cover frame integrally with handhole structure.
C. Hardware: Install removable hardware, including pulling eyes, cable stanchions, and cable arms as required for installation and support of cables and conductors and as indicated.

D. Field-Installed Bolting Anchors in Manholes and Concrete Handholes: Do not drill deeper than 3-7/8 inches for manholes and 2 inches for handholes, for anchor bolts installed in the field. Use a minimum of two anchors for each cable stanchion.

3.6 INSTALLATION OF HANDHOLES AND BOXES OTHER THAN PRECAST CONCRETE

A. Install handholes and boxes level and plumb and with orientation and depth coordinated with connecting ducts to minimize bends and deflections required for proper entrances. Use box extension if required to match depths of ducts and seal joint between box and extension as recommended by the manufacturer.

B. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1/2-inch sieve to No. 4 sieve and compacted to same density as adjacent undisturbed earth.

C. Elevation: In paved areas and trafficways, set so cover surface will be flush with finished grade. Set covers of other handholes 1 inch above finished grade.

D. Install handholes and boxes with bottom below the frost line.

E. Install removable hardware, including pulling eyes, cable stanchions, cable arms, and insulators, as required for installation and support of cables and conductors and as indicated. Select arm lengths to be long enough to provide spare space for future cables, but short enough to preserve adequate working clearances in the enclosure.

F. Field-cut openings for ducts and conduits according to enclosure manufacturer’s written instructions. Cut wall of enclosure with a tool designed for material to be cut. Size holes for terminating fittings to be used, and seal around penetrations after fittings are installed.

G. For enclosures installed in asphalt paving and subject to occasional, nondeliberate, heavy-vehicle loading form and pour a concrete ring encircling and in contact with, enclosure and with top surface screeded to top of box cover frame.
   1. Concrete: 3000 psi, 28-day strength, with a troweled finish.
   2. Dimensions: 12 inches wide by 12 inches deep.

3.7 GROUNDING

A. Ground underground ducts and utility structures according to Division 26 Section “Grounding and Bonding for Electrical Systems.”

3.8 FIELD QUALITY CONTROL

A. Perform the following tests and inspections and prepare test reports.
   1. Demonstrate capability and compliance with requirements on completion of installation of underground ducts and utility structures.
   2. Pull aluminum or wood test mandrel through duct to prove joint integrity and test for out-of-round duct. Provide mandrel equal to 80 percent fill of duct. If obstructions are indicated, remove obstructions and retest.

B. Correct deficiencies and retest as specified above to demonstrate compliance.
3.9 CLEANING

A. Pull leather-washer-type duct cleaner, with graduated washer sizes, through full length of ducts. Follow with rubber duct swab for final cleaning and to assist in spreading lubricant throughout ducts.

END OF SECTION
SECTION 26 05 53 - IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:
   1. Identification for conductors and communication and control cable.
   2. Warning labels and signs.
   3. Instruction signs.
   4. Equipment identification labels.
   5. Miscellaneous identification products.

1.2 SUBMITTALS

A. Product Data: For each electrical identification product indicated.

B. Identification Schedule: An index of nomenclature of electrical equipment and system components used in identification signs and labels.

1.3 QUALITY ASSURANCE


B. Comply with NFPA 70.

C. Comply with NFPA 70E


1.4 COORDINATION


B. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.

C. Coordinate installation of identifying devices with location of access panels and doors.

PART 2 - PRODUCTS

2.1 CONDUCTOR AND COMMUNICATION – AND CONTROL-CABLE IDENTIFICATION MATERIALS.

A. Color-Coding Conductor Tape: Colored, self-adhesive vinyl tape not less than 3 mils thick by 1 to 2 inches wide.

B. Marker Tapes: vinyl or vinyl-cloth, self-adhesive wraparound type, with circuit identification legend machine printed by thermal transfer or equivalent process.
2.2 WARNING LABEL AND SIGNS

A. Comply with NFPA 70 and 29 CFR 1910.145 and NFPA 70E.

B. 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.

C. Metal-Backed, Butyrate Warning Signs: Weather-resistant, nonfading, preprinted, cellulose-acetate butyrate signs with 0.0396-inch galvanized-steel backing; and with colors, legend and size required for application. ¼ inch grommets in corners for mounting. Nominal size, 10 by 14 inches.

D. Sample warning label and sign shall include, but are not limited to the following legends:
   1. Multiple Power source Warning: “DANGER – ELECTRICAL SHOCK HAZARD – EQUIPMENT HAS MULTIPLE POWER SOURCES.”
   2. Workspace Clearance Warning: “WARNING - OSHA REGULATION – AREA IN FRONT OF ELECTRICAL EQUIPMENT MUST BE KEPT CLEAR FOR 36 INCHES.”
   3. WARNING – ARC FLASH AND SHOCK HAZARD – APPROPRIATE PPE REQUIRED.

2.3 INSTRUCTION SIGNS

A. Engraved, laminated acrylic or melamine plastic, minimum 1/16 inch thick for signs up to 20 sq. in. and 1/8 inch thick for larger sized.
   1. Engraved legend with black letters on white face.
   2. Punched or drilled for mechanical fasteners.
   3. Framed with mitered acrylic molding and arranged for attachment at applicable equipment.

2.4 EQUIPMENT IDENTIFICATION LABELS


B. Stenciled Legend: In nonfading, waterproof, black ink or paint. Minimum letter height shall be 1 inch.

2.5 MISCELLANEOUS IDENTIFICATION PRODUCTS.

A. Cable ties: fungus-inert, self-extinguishing, 1-piece, self-locking, type 6/6 nylon cable ties.
   2. Tensile Strength: 50 lb minimum.
   3. Temperature Range: Minus 40 to plus 185 degrees F.

B. Fasteners for Labels and Signs: Self-tapping, stainless-steel screws or stainless-steel machine screws with nuts and flat and lock washers.

PART 3 - EXECUTION

3.1 APPLICATION

A. Outlet Boxes for Receptacles: Identify branch circuit by panel name and circuit number.
B. Power-Circuit Conductor Identification: of secondary conductors No. 1/0 AWG and larger in vaults, pull and junction boxes, manholes, and handholes use color-coding conductor tape. Identify source and circuit number of each set of conductors. For single conductor cables, identify phase in addition to the above.

C. Branch-Circuit Conductor Identification: Where there are conductors for more than three branch circuits in same junction or pull box, use color-coding conductor tape. Identify each ungrounded conductor according to source and circuit number.

   1. Identify conductors, cables and terminals in enclosures and at junctions, terminals, and pull points. Identify by system and circuit designation.
   2. Use system of marker type designations that is uniform and consistent with system used by manufacturer for factory-installed connections.

E. Warning Labels for Indoor Cabinets, Boxes and Enclosures for Power and Lighting: comply with 29 CFR 1910.145 and apply metal-backed, butyrate warning signs. Identify system voltage with black letters on an orange background. Apply to exterior of door, cover or other access.
   1. Equipment with Multiple Power or Control Sources: Apply to door or cover of equipment including, but not limited to the following:
      a. Power transfer switches
      b. Controls with external control power connections.
   2. 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.

F. Instruction Signs:
   1. Operating Instructions: Install instruction signs to facilitate proper operation and maintenance of electrical systems and items to which they connect. Install instruction signs with approved legend where instructions are needed for system or equipment operation.
   2. Emergency Operating Instructions: Install instruction signs with white legend on a red background with minimum 3/8 inch high letters for emergency instructions at equipment used for power transfer.

G. 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. Systems include power, lighting, control, communication, signal, monitoring, and alarm systems unless equipment is provided with its own identification.
   1. Labeling Instructions:
      a. Indoor Equipment: Engraved, laminated acrylic or melamine label. Unless otherwise indicated, provide a single line of text with ½-inch high letters on 1-1/2-inch high label; where 2 lines of text are required, use labels 2 inches high.
      b. Outdoor Equipment: Engraved, laminated acrylic or melamine label.
   2. Equipment to Be Labeled:
      a. Panelboards, electrical cabinets and enclosures.
      b. Access doors and panels for concealed electrical items.
      c. Electrical switchgear and switchboards.
      d. Transformers.
      e. Motor-control centers.
      f. Disconnect switches.
g. Enclosed circuit breakers.
h. Motor starters.
i. Push-bottom stations.
j. Power transfer equipment.
k. Contactors.
l. Remote-controlled switches and control devices.
m. Power-generating units.
n. Voice and data cable terminal equipment.
o. Terminals, racks and patch panels for voice and data communications and for signal and control functions.

3.2 INSTALLATION

A. Verify identity of each item before installing identification products.

B. Location: Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment.

C. Apply identification devices to surfaces that require finish after completing finish work.

D. Self-Adhesive Identification Products: Clean surfaces before application, using materials and methods recommended by manufacturer of identification device.

E. Attach nonadhesive signs and plastic labels with screws and auxiliary hardware appropriate to the location and substrate.

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 or, for sized larger than No. 6 AWG if authorities having jurisdiction permit, field applied.
   2. Colors for 480/277-V Circuits:
      a. Phase A: Brown
      b. Phase B: Orange
      c. Phase C: Yellow
   3. Field-Applied, Color-Coding Conductor Tape: Apply in half-lapped turns for a minimum distance of 6 inches from terminal points and in boxes where splices or taps are made. Apply last two turns of tape with no tension to prevent possible unwinding. Locate bands to avoid obscuring factory cable markings.

END OF SECTION
SECTION 26 22 00 - LOW-VOLTAGE TRANSFORMERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following types of dry-type transformers rated 600 V and less, with capacities up to 1000 kVA:
   1. Dry-Type distribution transformers.

1.3 SUBMITTALS

A. Product Data: Include rated nameplate data, capacities, weights, dimensions, minimum clearances, installed devices and features and performance for each type and size of transformer indicated.

B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components and location and size of each field connection.

C. Qualification Data: For testing agency

D. Source quality-control test reports.

E. Field quality-control test reports.

F. Operation and Maintenance Data: For transformers to include in emergency, operation and maintenance manuals.

1.4 QUALITY ASSURANCE

A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7.

B. Source Limitations: Obtain each transformer type through one source from a single manufacturer.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction and marked for intended use.

D. Comply with IEEE C57.12.91, “Test Code for Dry-Type Distribution and Power Transformers.”

1.5 DELIVERY, STORAGE AND HANDLING

A. Temporary Heating: Apply temporary heat according to manufacturer’s written instructions within the enclosure of each ventilated-type unit, throughout periods during which equipment is
not energized and when transformer is not in a space that is continuously under normal control of temperature and humidity.

### 1.6 COORDINATION

A. Coordinate size and location of concrete bases with actual transformer provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03. Construct housekeeping pad for floor mounted transformers.

B. Coordinate installation of wall-mounting and structure-hanging supports with actual transformer provided.

### PART 2 - PRODUCTS

#### 2.1 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

1. Square D; Schneider Electric.

#### 2.2 GENERAL TRANSFORMER REQUIREMENTS

A. Description: Factory-assembled and –tested, air-cooled units for 60-Hz service.

B. Cores: Grain-oriented, non-aging silicon steel.

C. Coils: Continuous windings without splices except for taps.

1. Internal Coil Connections: Brazed or pressure type.
2. Coil Material: Aluminum

#### 2.3 DISTRIBUTION TRANSFORMERS

A. Comply with NEMA ST 20, and list and label as complying with UL 1561.

B. Cores: One leg per phase.

C. Enclosure: Ventilated, NEMA 250, Type 2 for indoor applications.

1. Core and coil shall be encapsulated within resin compound, sealing out moisture and air.

D. Enclosure: Totally Enclosed, non-ventilated, Type 3R for outdoor applications.

1. Core and coil shall be encapsulated within resin compound, sealing out moisture and air.

E. Taps for Transformers 7.5 to 24 kVA: Two 5 percent taps below rated voltage.

F. Taps for Transformers 25 kVA and Larger: Two 2.5 percent taps above and two 2.5 percent taps below normal full capacity.

G. Insulation Class: 220 deg C, UL-component-recognized insulation system with a maximum of 115 deg C rise above 40 deg C ambient temperature.

H. 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.
I. Electrostatic Shielding: Each winding shall have an independent, single full-width copper electrostatic shield arranged to minimize interwinding capacitance.
   1. Arrange coil leads and terminal strips to minimize capacitive coupling between input and output terminals.
   2. Include special terminal for grounding the shield.
   3. Shield Effectiveness:
      a. Capacitance between Primary and Secondary windings: Not to exceed 33 picofarads over a frequency range of 20 Hz to 1 MHz.
      b. Common-Mode Noise Attenuation: Minimum of minus 120 dBA at 0.5 to 1.5 kHz; minimum of minus 65 dBA at 1.5 to 100 kHz.
      c. Normal-Mode Noise Attenuation: Minimum of minus 52 dBA at 1.5 to 10 kHz.

J. Wall Brackets: Manufacturer’s standard brackets.

K. Low-Sound-Level Requirements: Minimum of 3 dBA less than NEMA ST 20 standard sound levels when factory tested according to IEEE C57.12.91.

2.4 IDENTIFICATION DEVICES

A. Nameplates: Engraved, laminated-plastic or metal nameplate for each distribution transformer, mounted with corrosion-resistant screws. Nameplates and label products are specified in Division 26 Section “Identification for Electrical Systems.”

2.5 SOURCE QUALITY CONTROL

A. Test and inspect transformers according to IEEE C57.12.91.

B. Factory Sound-Level Tests: Conduct sound-level tests on equipment for this Project.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine conditions for compliance with enclosure and ambient temperature requirements for each transformer.

B. Verify that field measurements are as needed to maintain working clearances required by NFPA 70 and manufacturer’s written instructions.

C. Examine walls, floors, roofs, and concrete bases for suitable mounting conditions where transformers will be installed.

D. Verify that ground connections are in place and requirements in Division 16 Section “Grounding and Bonding for Electrical systems” have been met. Maximum ground resistance shall be 5 ohms at location of transformer.

E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install wall-mounting transformers level and plumb with wall brackets fabricated by transformer manufacturer.

B. Construct concrete bases and anchor floor-mounting transformers according to manufacturer’s written instructions and requirements.
C. Ground the neutral on the secondary of all transformers.

3.3 CONNECTIONS

A. Ground equipment according to Division 26 Section “Grounding and Bonding for Electrical Systems.”

B. Connect wiring according to Division 26 Section “Low-Voltage Electrical Power Conductors and Cables.”

3.4 FIELD QUALITY CONTROL

A. Perform tests and inspections and prepare test reports.

B. Tests and Inspections:
   1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.

C. Remove and replace units that do not pass tests or inspections and retest as specified above.

D. Test Labeling: On completion of satisfactory testing of each unit, attach a dated and signed “Satisfactory Test” label to tested component.

3.5 ADJUSTING

A. Monitor transformer secondary voltage at each unit for at least 2 hours of typical occupancy period. Adjust transformer taps to provide optimum voltage conditions at secondary terminals. Optimum is defined as not exceeding nameplate voltage plus 10 percent and not being lower than nameplate voltage minus 3 percent at maximum load conditions. Submit recording and tap settings as test results.

B. Output Settings Report: Prepare a written report recording output voltages and tap settings.

3.6 CLEANING

A. Vacuum dirt and debris; do not use compressed air to assist in cleaning.

END OF SECTION
SECTION 26 24 13 - SWITCHBOARDS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Service and distribution switchboards rated 600 V and less.

1.2 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Switchboards shall withstand the effects of earthquake motions determined according to SEI/ASCE 7.
   1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

1.3 SUBMITTALS

A. Product Data: For each type of switchboard, overcurrent protective device, transient voltage suppression device, ground-fault protector, accessory, and component indicated. Include dimensions and manufacturers’ technical data on features, performance, electrical characteristics, ratings, accessories, and finishes.

B. Shop Drawings: For each switchboard and related equipment.
   1. Include dimensioned plans, elevations, sections, and details, including required clearances and service space around equipment. Show tabulations of installed devices, equipment features, and ratings.
   2. Detail enclosure types for types other than NEMA 250, Type 1.
   3. Detail bus configuration, current, and voltage ratings.
   5. Include descriptive documentation of optional barriers specified for electrical insulation and isolation.
   6. Detail utility company’s metering provisions with indication of approval by utility company.
   7. Include evidence of NRTL listing for series rating of installed devices.
   8. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
   9. Include time-current coordination curves for each type and rating of overcurrent protective device included in switchboards. Submit on translucent log-log graft paper; include selectable ranges for each type of overcurrent protective device.
   10. Include schematic and wiring diagrams for power, signal, and control wiring.

C. Qualification Data: For qualified Installer.

D. Seismic Qualification Certificates: Submit certification that switchboards, overcurrent protective devices, accessories, and components will withstand seismic forces defined in Division 26 Section "Vibration and Seismic Controls for Electrical Systems." Include the following:
   1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
   2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
   3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

E. Field Quality-Control Reports:
1. Test procedures used.
2. Test results that comply with requirements.
3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.

F. Operation and Maintenance Data: For switchboards and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:
   1. Routine maintenance requirements for switchboards and all installed components.
   2. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
   3. Time-current coordination curves for each type and rating of overcurrent protective device included in switchboards. Submit on translucent log-log graft paper; include selectable ranges for each type of overcurrent protective device.

1.4 QUALITY ASSURANCE

   A. Installer Qualifications: An employer of workers qualified as defined in NEMA PB 2.1 and trained in electrical safety as required by NFPA 70E.

   B. Source Limitations: Obtain switchboards, overcurrent protective devices, components, and accessories from single source from single manufacturer.

   C. Product Selection for Restricted Space: Drawings indicate maximum dimensions for switchboards including clearances between switchboards and adjacent surfaces and other items. Comply with indicated maximum dimensions.

   D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

   E. Comply with NEMA PB 2.

   F. Comply with NFPA 70.

   G. Comply with UL 891.

1.5 DELIVERY, STORAGE, AND HANDLING

   A. Deliver switchboards in sections or lengths that can be moved past obstructions in delivery path.

   B. Remove loose packing and flammable materials from inside switchboards and install temporary electric heating (250W per section) connect factory-installed space heaters to temporary electrical service to prevent condensation.

   C. Handle and prepare switchboards for installation according to NEMA PB 2.1.

1.6 PROJECT CONDITIONS

   A. Installation Pathway: Remove and replace access fencing, doors, lift-out panels, and structures to provide pathway for moving switchboards into place.

   B. Environmental Limitations:
      1. Do not deliver or install switchboards until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work above switchboards is complete, and
temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

2. Rate equipment for continuous operation under the following conditions unless otherwise indicated:
   a. Ambient Temperature: Not exceeding 104 deg F (40 deg C).

C. Service Conditions: NEMA PB 2, usual service conditions, as follows:
   1. Ambient temperatures within limits specified.
   2. Altitude not exceeding 6600 feet (2000 m).

D. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:
   1. Notify Owner no fewer than seven days in advance of proposed interruption of electric service.
   2. Indicate method of providing temporary electric service.
   3. Do not proceed with interruption of electric service without Owner’s written permission.
   4. Comply with NFPA 70E.

1.7 COORDINATION

A. Coordinate layout and installation of switchboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

B. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

1.8 WARRANTY

A. Special Warranty: Manufacturer’s standard form in which manufacturer agrees to repair or replace transient voltage suppression devices that fail in materials or workmanship within specified warranty period.
   1. Warranty Period: 1 year from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURED UNITS

A. Basis-of-Design Product: Subject to compliance with requirements, provide product by the following:
   1. Schneider Electric – Square D

B. Front-Connected, Front-Accessible Switchboards:
   1. Main Devices: Fixed, individually mounted.
   3. Sections front and rear aligned.

C. Nominal System Voltage: 480Y/277 V and as indicated on the drawings.

D. Main-Bus Continuous: As indicated on the drawings.
E. Seismic Requirements: Fabricate and test switchboards according to IEEE 344 to withstand seismic forces at the project location.

F. Indoor Enclosures: Steel, NEMA 250, Type 1.

G. Outdoor Enclosure: Stainless Steel, Type 4.

H. Enclosure Finish for Indoor Units: Factory-applied finish in manufacturer's standard gray finish over a rust-inhibiting primer on treated metal surface.

I. Barriers: Between adjacent switchboard sections.

J. Insulation and isolation for main bus of main section and main and vertical buses of feeder sections.

K. Customer Metering Compartment: A separate customer metering compartment and section with front hinged door, for indicated metering, and current transformers for each meter. Current transformer secondary wiring shall be terminated on shorting-type terminal blocks. Include potential transformers having primary and secondary fuses with disconnecting means and secondary wiring terminated on terminal blocks.

L. Surge Protection Devices: Where indicated on drawings, switchboards shall include surge protective devices factory-installed meeting the following requirements:
   1. Comply with UL 1449, Type 2. Provide disconnecting means.
   2. Peak Surge Current Rating: The minimum single-pulse surge current withstand rating per phase shall not be less than 240 kA. The peak surge current rating shall be the arithmetic sum of the ratings of the individual MOVs in a given mode.
   3. Protection modes and UL 1449 VPR for grounded wye circuits with 480Y/277 V, three-phase, four-wire circuits shall not exceed the following:
      a. Line to Neutral: 1200 V.
      b. Line to Ground: 1200 V.
      c. Line to Line: 2000 V
   4. SCCR: Equal or exceed the short circuit current rating of the switchboard.
   5. Inominal Rating: 20 kA.

M. Key Interlocking: Where indicated on drawings, provide a key interlocking system for indicated circuit breakers to prevent simultaneous energization of multiple sources.

N. Bus Transition and Incoming Pull Sections: Matched and aligned with basic switchboard.

O. Hinged Front Panels: Allow access to circuit breaker, metering, accessory, and blank compartments.

P. Pull Box on Top of Switchboard:
   1. Adequate ventilation to maintain temperature in pull box within same limits as switchboard.
   2. Set back from front to clear circuit-breaker removal mechanism.
   3. Removable covers shall form top, front, and sides. Top covers at rear shall be easily removable for drilling and cutting.
   4. Bottom shall be insulating, fire-resistive material with separate holes for cable drops into switchboard.
   5. Cable supports shall be arranged to facilitate cabling and adequate to support cables indicated, including those for future installation.
Q. Buses and Connections: Three phase, four wire unless otherwise indicated.
   1. Phase- and Neutral-Bus Material: Hard-drawn copper of 98 percent conductivity, with tin-plated aluminum or copper feeder circuit-breaker line connections.
   2. Load Terminals: Insulated, rigidly braced, runback bus extensions, of same material as through buses, equipped with compression connectors for outgoing circuit conductors. Provide load terminals for future circuit-breaker positions at full-ampere rating of circuit-breaker position.
   3. Ground Bus: 1/4 by 1-inch or the minimum-size required by UL 891, hard-drawn copper of 98 percent conductivity, equipped with compression connectors for feeder and branch-circuit ground conductors. For busway feeders, extend insulated equipment grounding cable to busway ground connection and support cable at intervals in vertical run.
   4. Main Phase Buses and Equipment Ground Buses: Uniform capacity for entire length of switchboard's main and distribution sections. Provide for future extensions from both ends.
   5. Neutral Buses: 100 percent of the ampacity of phase buses unless otherwise indicated, equipped with compression connectors for outgoing circuit neutral cables. Brace bus extensions for busway feeder neutral bus.

R. Multifunction Digital-Metering Monitor: UL-listed or -recognized, microprocessor-based unit suitable for three-or-four-wire systems and with the following features:
   1. Inputs from sensors or 5-A current-transformer secondaries, and potential terminals rated to 600 V.
   2. Switch-selectable digital display of the following:
      a. Phase Currents, Each Phase: Plus or minus 1 percent.
      b. Phase-to-Phase Voltages, Three Phase: Plus or minus 1 percent.
      c. Phase-to-Neutral Voltages, Three Phase: Plus or minus 1 percent.
      d. Three-Phase Real Power: Plus or minus 2 percent.
      e. Three-Phase Reactive Power: Plus or minus 2 percent.
      f. Power Factor: Plus or minus 2 percent.
      g. Frequency: Plus or minus 0.5 percent.
      h. Integrated Demand with Demand Interval Selectable from 5 to 60 Minutes: Plus or minus 2 percent.
   3. Mounting: Display and control unit flush or semi-flush mounted in instrument compartment door.
   4. Unit to have ethernet port for connection to external monitoring system.

S. Future Devices: Equip compartments with mounting brackets, supports, bus connections, and appurtenances at full rating of circuit-breaker compartment.

T. Disconnecting And Overcurrent Protective Devices
   1. Molded-Case Circuit Breaker (MCCB): Comply with UL 489, with interrupting capacity to meet available fault currents.
      b. Electronic Trip Unit Circuit Breakers: RMS Sensing; field-replaceable rating plug; with the following field-adjustable settings or as indicated on the drawings:
         1) Instantaneous trip.
         2) Long-and short-time pickup levels.
         3) Long-and short-time time adjustments.
         4) Ground-fault pickup level, time delay and l^2t response.
      c. Provide arc reduction maintenance mode (ARMS) feature for all circuit breakers rated 1200A and larger.
      d. Ground-Fault Protection: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
Provide ground fault protection for all circuit breakers rated 1000A or larger, or as indicated on drawings

e. GFCI Circuit Breakers: Single- and two-pole configurations with Class A ground-fault protection (6-mA trip).
g. Molded-Case Circuit-Breaker (MCCB) Features and Accessories:
   1) Standard frame sizes, trip ratings, and number of poles.
   2) Lugs: Mechanical style, suitable for number, size, trip ratings, and conductor materials.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Receive, inspect, handle, and store switchboards according to NEMA PB 2.1.

B. Examine switchboards before installation. Reject switchboards that are moisture damaged or physically damaged.

C. Examine elements and surfaces to receive switchboards for compliance with installation tolerances and other conditions affecting performance of the Work.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install switchboards and accessories according to NEMA PB 2.1.

B. Equipment Mounting: Install floor mounted switchboards on concrete base, 4-inch (100-mm) nominal thickness. Comply with requirements for concrete base specified in Division 03 Section "Cast-In-Place Concrete or Miscellaneous Cast-In-Place Concrete."
   1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of concrete base.
   2. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
   3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
   4. Install anchor bolts to elevations required for proper attachment to switchboards.

C. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from switchboard units and components.

D. Comply with mounting and anchoring requirements specified in Division 26 Section "Vibration and Seismic Controls for Electrical Systems."

E. Operating Instructions: Frame and mount the printed basic operating instructions for switchboards, including control and key interlocking sequences and emergency procedures. Fabricate frame of finished wood or metal and cover instructions with clear acrylic plastic. Mount on front of switchboards.

F. Install filler plates in unused spaces of panel-mounted sections.
Section 26 24 13

3.3 CONNECTIONS

A. Comply with requirements for terminating feeder bus specified in Division 26 Section "Enclosed Bus Assemblies." Drawings indicate general arrangement of bus, fittings, and specialties.

B. Comply with requirements for terminating cable trays specified in Division 26 Section "Cable Trays for Electrical Systems." Drawings indicate general arrangement of cable trays, fittings, and specialties.

3.4 IDENTIFICATION

A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

B. Switchboard Nameplates: Label each switchboard compartment with a nameplate complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

C. Device Nameplates: Label each disconnecting and overcurrent protective device and each meter and control device mounted in compartment doors with a nameplate complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

3.5 FIELD QUALITY CONTROL

A. Perform tests and inspections.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

B. Acceptance Testing Preparation:

1. Test insulation resistance for each switchboard bus, component, connecting supply, feeder, and control circuit.
2. Test continuity of each circuit.

C. Tests and Inspections:

1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
3. Perform the following infrared scan tests and inspections and prepare reports:

   a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each switchboard. Remove front panels so joints and connections are accessible to portable scanner.

   b. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each switchboard 11 months after date of Substantial Completion.
c. Instruments and Equipment:
   1) Use an infrared scanning device designed to measure temperature or to
detect significant deviations from normal values. Provide calibration record
for device.

4. Test and adjust controls, remote monitoring, and safeties. Replace damaged and
malfunctioning controls and equipment.

D. Switchboard will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports, including a certified report that identifies switchboards
included and that describes scanning results. Include notation of deficiencies detected,
remedial action taken, and observations after remedial action.

3.6 ADJUSTING

A. Adjust moving parts and operable components to function smoothly, and lubricate as
recommended by manufacturer.

B. Set field-adjustable circuit-breaker trip ranges as indicated.

3.7 PROTECTION

A. Temporary Heating: Apply temporary heat, to maintain temperature according to
manufacturer's written instructions, until switchboard is ready to be energized and placed into
service.

3.8 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain switchboards,
overcurrent protective devices, instrumentation, and accessories, and to use and reprogram
microprocessor-based trip, monitoring and communication units.

END OF SECTION
SECTION 26 24 16 - PANELBOARDS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:
   1. Distribution panelboards.
   2. Lighting and appliance branch-circuit panelboards.

1.3 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Panelboards shall withstand the effects of earthquake motions determined according to SEI/ASCE 7.
   1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

1.4 SUBMITTALS

A. Product Data: For each type of panelboard, switching and overcurrent protective device, transient voltage suppression device, accessory, and component indicated. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.

B. Shop Drawings: For each panelboard and related equipment.
   1. Include dimensioned plans, elevations, sections, and details. Show tabulations of installed devices, equipment features, and ratings.
   2. Detail enclosure types and details for types other than NEMA 250, Type 1.
   3. Detail bus configuration, current, and voltage ratings.
   4. Short-circuit current rating of panelboards and overcurrent protective devices.
   5. Include evidence of NRTL listing for series rating of installed devices.
   6. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
   7. Include wiring diagrams for power, signal, and control wiring.
   8. Include time-current coordination curves for each type and rating of overcurrent protective device included in panelboards. Submit on translucent log-log graft paper; include selectable ranges for each type of overcurrent protective device.

C. Seismic Qualification Certificates: Submit certification that panelboards, overcurrent protective devices, accessories, and components will withstand seismic forces defined in Division 26 Section "Vibration and Seismic Controls for Electrical Systems." Include the following:
   1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
   2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
   3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

D. Field Quality-Control Reports:
1. Test procedures used.
2. Test results that comply with requirements.
3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.

E. Panelboard Schedules: For installation in panelboards. Submit final versions after load balancing.

F. Operation and Maintenance Data: For panelboards and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:
1. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
2. Time-current curves, including selectable ranges for each type of overcurrent protective device that allows adjustments.

1.5 QUALITY ASSURANCE

A. Source Limitations: Obtain panelboards, overcurrent protective devices, components, and accessories from single source from single manufacturer.

B. Product Selection for Restricted Space: Drawings indicate maximum dimensions for panelboards including clearances between panelboards and adjacent surfaces and other items. Comply with indicated maximum dimensions.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

D. Comply with NEMA PB 1.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Remove loose packing and flammable materials from inside panelboards; install temporary electric heating (250 W per panelboard) to prevent condensation.

B. Handle and prepare panelboards for installation according to NEMA PB 1.

1.7 PROJECT CONDITIONS

A. Environmental Limitations:
1. Do not deliver or install panelboards until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work above panelboards is complete, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.
2. Rate equipment for continuous operation under the following conditions unless otherwise indicated:
   a. Ambient Temperature: Not exceeding 23 deg F (minus 5 deg C) to plus 104 deg F (plus 40 deg C).

B. Service Conditions: NEMA PB 1, usual service conditions, as follows:
1. Ambient temperatures within limits specified.
2. Altitude not exceeding 6600 feet (2000 m).
C. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:
   1. Notify Owner no fewer than two days in advance of proposed interruption of electric service.
   2. Do not proceed with interruption of electric service without Owner's written permission.
   3. Comply with NFPA 70E.

1.8 COORDINATION

A. Coordinate layout and installation of panelboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

B. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

1.9 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace transient voltage suppression devices that fail in materials or workmanship within specified warranty period.
   1. Warranty Period: 1 year from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR PANELBOARDS

A. Fabricate and test panelboards according to IEEE 344 to withstand seismic forces defined in Division 26 Section "Vibration and Seismic Controls for Electrical Systems."

B. Enclosures: Surface-mounted cabinets.
   1. Rated for environmental conditions at installed location.
      a. Indoor Dry and Clean Locations: NEMA 250, Type 1.
      b. Indoor Damp or Wet Locations: Type 4X stainless steel.
      c. Outdoor Locations: Type 4X stainless steel.
   2. Front: Secured to box with concealed trim clamps. For surface-mounted fronts, match box dimensions; for flush-mounted fronts, overlap box.
   3. Hinged Front Cover: Entire front trim hinged to box and with standard door within hinged trim cover.
   4. Skirt for Surface-Mounted Panelboards: Same gage and finish as panelboard front with flanges for attachment to panelboard, wall, and ceiling or floor.
   5. Gutter Extension and Barrier: Same gage and finish as panelboard enclosure; integral with enclosure body. Arrange to isolate individual panel sections.
   6. Finishes:
      a. Panels and Trim: Steel, factory finished immediately after cleaning and pretreating with manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat.
C. Incoming Mains Location: Top and bottom as required by job conditions.

D. Phase, Neutral, and Ground Buses:
   2. Equipment Ground Bus: Adequate for feeder and branch-circuit equipment grounding conductors; bonded to box.

E. Conductor Connectors: Suitable for use with conductor material and sizes.
   2. Main and Neutral Lugs: Compression type.
   3. Ground Lugs and Bus-Configured Terminators: Compression type.
   4. Extra-Capacity Neutral Lugs: Rated 200 percent of phase lugs mounted on extra-capacity neutral bus.

F. Service Equipment Label: NRTL labeled for use as service equipment for panelboards or load centers with one or more main service disconnecting and overcurrent protective devices.

G. Future Devices: Mounting brackets, bus connections, filler plates, and necessary appurtenances required for future installation of devices.


2.2 DISTRIBUTION PANELBOARDS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Square D; a brand of Schneider Electric.

B. Panelboards: NEMA PB 1, power and feeder distribution type.

C. Doors: Secured with vault-type latch with tumbler lock; keyed alike.
   1. For doors more than 36 inches (914 mm) high, provide two latches, keyed alike.

D. Mains: Circuit breaker.


F. Branch Overcurrent Protective Devices for Circuit-Breaker Frame Sizes Larger Than 125 A: Bolt-on circuit breakers; plug-in circuit breakers where individual positive-locking device requires mechanical release for removal.

2.3 LIGHTING AND APPLIANCE BRANCH-CIRCUIT PANELBOARDS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Square D; a brand of Schneider Electric.

B. Panelboards: NEMA PB 1, lighting and appliance branch-circuit type.

C. Mains: Circuit breaker.

D. Branch Overcurrent Protective Devices: Bolt-on circuit breakers, replaceable without disturbing adjacent units.
E. Doors: Concealed hinges; secured with flush latch with tumbler lock; keyed alike.

F. Column-Type Panelboards: Narrow gutter extension, with cover, to overhead junction box equipped with ground and neutral terminal buses.

2.4 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Square D; a brand of Schneider Electric.

B. Molded-Case Circuit Breaker (MCCB): Comply with UL 489, with interrupting capacity to meet available fault currents.
   2. GFCI Circuit Breakers: Single- and two-pole configurations with Class A ground-fault protection (6-mA trip).
   4. Molded-Case Circuit-Breaker (MCCB) Features and Accessories:
      a. Standard frame sizes, trip ratings, and number of poles.
      b. Lugs: Mechanical style, suitable for number, size, trip ratings, and conductor materials.
      c. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge (HID) lighting circuits.
      d. Application Listing: Appropriate for application; Type HACR for breakers serving Heating, Air Conditioning and Refrigeration (HACR) loads.
      e. Dual rated SWD and HACR breakers are acceptable.

2.5 ACCESSORY COMPONENTS AND FEATURES

A. Accessory Set: Include tools and miscellaneous items required for overcurrent protective device test, inspection, maintenance, and operation.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Receive, inspect, handle, and store panelboards according to NEMA PB 1.1.

B. Examine panelboards before installation. Reject panelboards that are damaged or rusted or have been subjected to water saturation.

C. Examine elements and surfaces to receive panelboards for compliance with installation tolerances and other conditions affecting performance of the Work.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install panelboards and accessories according to NEMA PB 1.1.
B. Equipment Mounting: Install panelboards on concrete bases, 4-inch (100-mm) nominal thickness. Comply with requirements for concrete base specified in Division 03 Section "Cast-in-Place Concrete or Miscellaneous Cast-in-Place Concrete."
   1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch (450-mm) centers around full perimeter of base.
   2. For panelboards, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
   3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
   4. Install anchor bolts to elevations required for proper attachment to panelboards.
   5. Attach panelboard to the vertical finished or structural surface behind the panelboard.

C. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from panelboards.

D. Comply with mounting and anchoring requirements specified in Division 26 Section "Vibration and Seismic Controls for Electrical Systems."

E. Mount top of trim 90 inches (2286 mm) above finished floor unless otherwise indicated.

F. Mount panelboard cabinet plumb and rigid without distortion of box. Mount recessed panelboards with fronts uniformly flush with wall finish and mating with back box.

G. Install overcurrent protective devices and controllers not already factory installed.
   1. Set field-adjustable, circuit-breaker trip ranges.

H. Install filler plates in unused spaces.

I. Stub four 1-inch (27-GRC) empty conduits from panelboard into accessible ceiling space or space designated to be ceiling space in the future. Stub four 1-inch (27-GRC) empty conduits into raised floor space or below slab not on grade.

J. Arrange conductors in gutters into groups and bundle and wrap with wire ties after completing load balancing.

K. Comply with NECA 1.

3.3 IDENTIFICATION

A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs complying with Division 26 Section "Identification for Electrical Systems."

B. Create a directory to indicate installed circuit loads; incorporate Owner's final room designations. Obtain approval before installing. Use a computer or typewriter to create directory; handwritten directories are not acceptable.

C. Panelboard Nameplates: Label each panelboard with a nameplate complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

D. Device Nameplates: Label each branch circuit device in distribution panelboards with a nameplate complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."
3.4 FIELD QUALITY CONTROL

A. Perform tests and inspections.
   1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

B. Acceptance Testing Preparation:
   1. Test insulation resistance for each panelboard bus, component, connecting supply, feeder, and control circuit.
   2. Test continuity of each circuit.

C. Tests and Inspections:
   1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
   2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
   3. Perform the following infrared scan tests and inspections and prepare reports:
      a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each panelboard. Remove front panels so joints and connections are accessible to portable scanner.
      b. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each panelboard 11 months after date of Substantial Completion.
      c. Instruments and Equipment:
         1). Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.

D. Panelboards will be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection reports, including a certified report that identifies panelboards included and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

F. ADJUSTING

G. Adjust moving parts and operable component to function smoothly, and lubricate as recommended by manufacturer.

H. Set field-adjustable circuit-breaker trip ranges as indicated and recommended by manufacturer.

I. Load Balancing: After Substantial Completion, but not more than 60 days after Final Acceptance, measure load balancing and make circuit changes if directed by the Engineer.
   1. Measure as directed during period of normal system loading.
   2. Perform load-balancing circuit changes outside normal occupancy/working schedule of the facility and at time directed. Avoid disrupting critical 24-hour services such as fax machines and on-line data processing, computing, transmitting, and receiving equipment.
   3. After circuit changes, recheck loads during normal load period. Record all load readings before and after changes and submit test records.
   4. Tolerance: Difference exceeding 20 percent between phase loads, within a panelboard, is not acceptable. Rebalance and recheck as necessary to meet this minimum requirement.
3.5 PROTECTION

A. Temporary Heating: Apply temporary heat to maintain temperature according to manufacturer's written instructions.

END OF SECTION
SECTION 26 24 19 - MOTOR-CONTROL CENTERS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes motor-control centers for use on ac circuits rated 600 V and less.

1.2 SUBMITTALS

A. Product Data: For each type of controller and each type of motor-control center. Include dimensions and manufacturer’s technical data on features, performance, electrical characteristics, ratings and finishes.

B. Shop Drawings: for each motor-control center.
   1. Include dimensioned plans, elevations, sections and details, including required clearances and service space around equipment. Show tabulations of installed devices, equipment features and ratings. Include the following:
      a. Each installed unit's type and details.
      b. Nameplate legends.
      c. Short-circuit current ratings of buses and installed units.
      d. Vertical and horizontal bus capacities.
      e. UL listing for series rating of overcurrent protective devices in combination controller.
      f. Features, characteristics, ratings, and factory settings of each motor-control center unit.
   2. Wiring Diagrams: Power, signal and control wiring for class and type of motor-control center. Provide schematic wiring diagram for each type of controller.

C. Coordination Drawings: floor plans, drawn to scale, showing dimensioned layout, required working clearances, and required area above and around motor-control centers where pipe and ducts are prohibited. Show motor-control center layout and relationships between electrical components and adjacent structural and mechanical elements. Show compliance with NFPA 70, Article 240.24 height limitation of overcurrent device operating handles. Show support locations, type of support and weight on each support. Indicate field measurements.

D. Qualification Data: for manufacturer and testing agency.

E. Field quality-control test reports.

F. Operation and Maintenance Data: for motor-control centers, all installed devices and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section “Operation and Maintenance Data,” include the following:
   1. Routine maintenance requirements for motor-control centers and all installed components.
   2. Manufacturer’s written instructions for testing and adjusting overcurrent protective devices.

G. Load-Current and Overload-Relay heater List: Compile after motors have been installed and arrange to demonstrate that selection of heaters suits actual motor nameplate full-load currents.

H. Load-Current and List of Settings of Adjustable Overload Relays: Compile after motors have been installed and arrange to demonstrate that dip switch settings for motor running overload protection suit actual motor to be protected.
1.3 QUALITY ASSURANCE
A. Manufacturer Qualifications: A qualified manufacturer. Maintain, within 250 miles of Project site, a service center capable of providing training, parts and emergency maintenance and repairs.
B. Source Limitations: Obtain motor-control centers and controllers of a single type through one source from a single manufacturer.
C. Electrical Components, Devices and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction and marked for intended use.
D. Comply with NFPA 70.

1.4 DELIVERY, STORAGE AND HANDLING
A. Deliver motor-control centers in shipping splits of lengths that can be moved past obstructions in delivery path as indicated.
B. Handle motor-control centers according to the following:
   1. NEMA ICS 2.3, “Instructions for the Handling, Installation, Operation and Maintenance of Motor Control Centers Rated Not More Than 600 Volts.”
   2. NECA 402, “Recommended Practice for Installing and Maintaining Motor Control Centers.”

1.5 COORDINATION
A. Coordinate layout and installation of motor-control centers with other construction including conduit, piping, equipment and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.
B. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases.
C. Coordinate features of motor-control centers, installed units, and accessory devices with pilot devices and control circuits to which they connect.
D. Coordinate features, accessories, and functions of each motor-control center, each controller, and each installed unit with ratings and characteristics of supply circuit, motor, required control sequence, and duty cycle of motor and load.

1.6 EXTRA MATERIALS
A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Spare fuses: Furnish one spare for every five installed, but no fewer than one set of three of each type and rating.
   2. Indicating Lights: Two of each type installed.

PART 2 - PRODUCTS

2.1 MANUFACTURER AND MODEL
A. Subject to compliance with requirements, provide a Schneider Electric Square D motor control center.
2.2 MOTOR-CONTROL CENTERS

A. Wiring: NEMA ICS 3, Class I, Type B.

B. Enclosures: Flush- or surface-mounting cabinets as indicated. NEMA 250, Type 1, unless otherwise indicated to comply with environmental conditions at installed location. Standard, 20” depth.
   1. Compartments: Modular; individual doors with concealed hinges and quick-captive screw fasteners. Interlocks on combination controller units requiring disconnecting means in off position before door can be opened or closed, except by operating a permissive release device.
   2. Interchangeability: Compartments constructed to allow for removal of units without opening adjacent doors, disconnecting adjacent compartments, or disturbing operation of other units in motor-control center; same size compartments to permit interchangeability and ready rearrangement of units, such as replacing three single units with a unit requiring three spaces, without cutting or welding.
   3. Final installation height of disconnect devices, accounting for pad height under the motor control center, shall be in compliance with NFPA 70, Article 240.24.
   4. Wiring spaces: Wiring channel in each vertical section for vertical and horizontal wiring to each unit compartment; supports to hold wiring in place.

C. Short-Circuit Current Rating for Each Section: Equal to or greater than indicated available fault current in symmetrical amperes at motor-control center location.

2.3 BUSES

A. Material: Plated hard-drawn copper, 98 percent conductivity.

B. Ampacity Ratings: As indicated for horizontal main buses.

C. Neutral Buses: Full size or as available relative to the main ampacity.

D. Equipment Ground Bus: Non-insulated, horizontal configuration; adequate for equipment ground conductors; bonded to enclosure.

E. Horizontal Bus Arrangement: Main phase, neutral and ground buses extended with same capacity the entire length of motor-control center, with provision for future extension at both ends by bolt holes and captive bus splice sections or equivalent.

F. Short-Circuit Withstand Rating: Same as short-circuit current rating of section.

2.4 FUNCTIONAL FEATURES

A. Description: Modular arrangement of controllers, control devices, overcurrent protective devices, transformers, panelboards, instruments, indicating panels, blank panels, and other items mounted in compartments of motor-control center.

B. Controller Units: Combination controller units of types and with features, ratings and circuit assignments indicated:
   1. Install units up to and including Size 3 on drawout mountings with connectors that automatically line up and connect with vertical-section buses while being racked into their normal, energized positions.
   2. Provide units with short-circuit current ratings equal to or greater than short-circuit current rating of motor-control center sections.
3. Equip units in Type B and Type C motor-control centers with pull-apart terminal strips or drawout terminal boards for external control connections.


C. Overcurrent Protective Devices: Individual feeder-tap units through 225-A rating shall have drawout mountings with connectors that automatically line up and connect with vertical-section buses while being racked into their normal, energized positions. Installed height, including that of the concrete base, of operating handles of overcurrent protective devices shall not exceed the height limitation of NFPA 70, Article 240.24.

D. Surge Protective Devices: Connect to motor-control center bus.

E. Spaces and Blank Units: Compartments fully bused and equipped with guide rails or equivalent, ready for insertion of drawout units.

F. Spare Units: Type, sizes, and ratings indicated; installed in compartments indicated “spare.”

G. Key Interlocking: Where indicated on drawings, provide a key interlocking system for indicated circuit breakers to prevent simultaneous energization of multiple sources.

2.5 ACROSS-THE-LINE CONTROLLERS

A. Magnetic Controller: NEMA ICS 2, Class A, full voltage, non-reversing, 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.

B. Combination Magnetic Controller: Factory-assembled combination of magnetic controller, OCPD, and disconnecting means.
   1. MCP Disconnecting Means:
      a. UL 489, NEMA AB 1, and NEMA AB 3, with interrupting capacity to comply with available fault currents, instantaneous-only circuit breaker with front-mounted, field-adjustable, short-circuit trip coordinated with motor locked-rotor amperes.
      b. Lockable Handle: Accepts three padlocks and interlocks with cover in closed position.
      c. Auxiliary NO/NC contact that operates to indicate “ON” or “OFF”.

C. Overloads: Solid state type, electronic design with a 5:1 adjustment range, current based measurement protection, thermal memory, integrated I/O points, and enhanced phase loss protection.

D. Motor controller buckets shall include control features as indicated on the contract documents, including but not limited to the following:
   1. HAND-OFF-AUTO three position selector switch
   2. Remote start input when selector switch in AUTO
   3. Stop pushbutton (normally closed)
   4. Start pushbutton (normally open)
   5. On indicator light (green)
   6. Off indicator light (red)
   7. Overload reset pushbutton
   8. Dry status contacts for motor running and overload
9. Other indication and control devices as indicated on the plans

2.6 VARIABLE FREQUENCY CONTROLLERS

A. Description: Where variable frequency drives are indicated on the one lines and plan view as an integral part of the motor control center lineup, furnish NEMA ICS 2, pulse-width-modulated, 6 pulse variable frequency controller; listed and labeled as a complete unit and arranged to provide variable speed of an NEMA MG 1, Design B, 3-phase, induction motor by adjusting output voltage and frequency.
   1. Provide unit suitable for operation of standard and premium-efficiency motor as defined by NEMA MG 1.
   2. 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.

B. Model: Provide Schneider Electric Model ATV930.

C. Design and Rating: Match load type such as fans, blowers, and pumps; and type of connection used between motor and load such as direct or through a power-transmission connection.

D. VFC shall meet or exceed the latest version of IEEE Standard 519 with regard to harmonics generated by the non-linear loads. Factory certification of IEEE 519 compliance shall be submitted to the engineer prior to shipment.

E. Line Reactor: Each variable frequency drive must be equipped with an input reactor or DC choke offering no less than 4.5% effective impedance at rated motor amps (the fundamental current). Reactors must be harmonic compensated and be UL-506 and UL-508 approved. The continuous current rating of the reactor must be equal to or greater than the rms input current rating of the drive. Reactors must be copper wound with a UL class H (180 C) insulation system. They must be suitable for an ambient temperature of 45 C and a have a maximum temperature rise of 115 C. Their watts loss must be less than 1% of the rated load. Box lug type terminals must be provided on all reactors rated from 2 amps thru 400 amps. Higher current reactors may be supplied with copper tab type terminals.

F. Output Filtering:
   1. For motor lead lengths 150-500 feet, provide dv/dt output filter, TCI V1k or equal.
   2. For motor lead lengths greater than 500 feet, provide motor sine wave filter, TCI MotorShield or equal.

G. Output Rating: 3-phase; 6 to 60 Hz, with voltage proportional to frequency throughout voltage range.

H. Unit Operating Requirements:
   1. Input ac voltage tolerance of 380 to 500 V, plus or minus 10 percent.
   2. Input frequency tolerance of 50/60 Hz, plus or minus 6 percent.
   3. Minimum Efficiency: 96 percent at 60 Hz, full load.
   4. Minimum Displacement Primary-Side Power Factor; 96 percent.
   5. Overload Capability: 1.1 times the base load current for 60 seconds, 2.0 times the base load current for 3 seconds.
   6. Starting Torque: 100 percent of rated torque or as indicated.
   7. Speed Regulation: Plus or minus 1 percent.
   8. Ambient Temperature: 0 to 40 degrees C.

I. Isolated control interface allows controller to follow control signal over an 11:1 speed range.
   1. Electrical Signal: 4 to 20 mA at 24 V.
J. Internal Adjustability Capabilities:
1. Minimum speed: 5 to 25 percent of maximum rpm.
2. Maximum Speed: 80 to 100 percent of maximum rpm.
3. Acceleration: 2 to a minimum of 22 seconds.
4. Deceleration: 2 to minimum of 22 seconds.
5. Current Limit: 50 to a minimum of 110 percent of maximum rating.

K. Self-Protection and Reliability Features:
1. Input transient protection by means of surge suppressors.
2. Under-and overvoltage trips; inverter overtemperature, overload, and overcurrent trips.
5. Instantaneous line-to-line and line-to-ground overcurrent trips.
7. Reverse-phase protection.
8. Short-circuit protection.

L. Automatic Reset/Restart: Attempts three restarts after controller fault before shutting down for manual reset or fault correction. Restarting during deceleration shall not damage controller, motor or load.

M. Power-Interruption Protection: Prevents motor from re-energizing after a power interruption until motor has stopped.

N. Variable frequency controllers shall include control features as indicated on the contract documents, including but not limited to the following:
   a. HAND-OFF-AUTO three position selector switch
   b. Remote start input when selector switch in AUTO
   c. Manual speed potentiometer
   d. On indicator light (green)
   e. VFD fault indicator light (red)
   f. Dry status contacts for motor running, VFD fault, and mode selection
   g. 4-20 mA speed command input
   h. 4-20 mA speed feedback
   i. Other indication and control devices as indicated on the plans.

O. Indicating Devices: Meters or digital readout devices and selector switch, mounted flush in controller door and connected to indicate controller output current, voltage, and frequency.

P. Integral disconnecting Means: NEMA AB1, instantaneous-trip circuit breaker with lockable handle.

2.7 FEEDER OVERCURRENT PROTECTION

   1. Electronic Trip Unit Circuit Breakers: RMS Sensing; field-replaceable rating plug; with the following field-adjustable settings. Provide long-time, short time, instantaneous, and ground fault features for circuit breakers as indicated on the one-line diagrams.
      a. Instantaneous trip.
      b. Long-and short-time pickup levels.
      c. Long-and short-time time adjustments.
d. Ground-fault pickup level, time delay and \( I^2t \) response.

B. Molded-Case Circuit-Breaker Features and Accessories: Standard frame sizes, trip ratings and number of poles.
   1. Lugs: Mechanical Compression style, suitable for number, size, trip ratings and material of conductors.
   2. Arc Reduction Maintenance Switch (ARMS): Provide an arc reduction maintenance switch for all circuit breakers rated 1200A or greater, or as indicated on drawings, meeting the requirements of NEC Article 240.
   3. Ground-Fault Protection: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator. Provide ground fault protection for all circuit breakers rated 1000A or larger, or as indicated on drawings.

2.8 TRANSFORMER AND PANELBOARD

A. Where indicated on drawings, provide step-down transformer and panelboard mounted integral to the motor control center.

B. Transformer shall be provided with a primary circuit breaker disconnect sized for the transformer kVA rating. Transformer size and secondary voltage shall be as indicated on the drawings. Transformer temperature rise shall not exceed 150 deg C.

C. Panelboard ampacity and voltage ratings shall be as indicated on the drawings. Panelboards and circuit breakers shall be rated for 10kAIC minimum.

D. Provide panelboard with main circuit breaker rating to match bus ampacity.

E. Panelboard busses shall be copper.

F. Provide panel spaces as indicated on drawings, or thirty (30) spaces, whichever is greater. Provide circuit breaker quantities and ratings as indicated on drawings. If non indicated, fill all spaces with 20A single pole breakers.

G. Panelboard shall be Square D NQ series.

2.9 COMMUNICATIONS

A. Ethernet Devices
   1. Motor Control Center assemblies shall be provided with a factory assembled Ethernet field bus communications network providing direct connectivity between MCC devices and the plant SCADA system.
   2. Ethernet 10/100/1000 auto negotiate layer 2 managed industrial switches shall be provided as required in the MCC lineup. The Ethernet switch shall have sufficient ports available to connect to each ethernet-capable device and have at least 2 open ports for a customer connection and a PC connection for maintenance. The Ethernet switch shall be mounted in the top removable unit of each vertical section or shipping split and not in the vertical wireway. If required by the application, the switch shall be capable of connecting to multiple sections.
   3. The Ethernet system installed in the MCC shall include a complete and tested cabling system. The cabling system shall be 600V Cat 6 and consist of home run connections from the device to a switch located in the MCC and in accordance with Ethernet specifications. Non-standard, non-shielded cable will not be accepted.
   4. All cabling shall be securely supported and attached to the MCC structure in accordance with the contract drawings and the manufacturer's recommendations.
5. Ethernet communications modules shall be provided at each device interfacing to the Ethernet field bus. The communications modules shall be installed in the unit device compartment or bucket, and shall be direct-connected to the Ethernet cable. Each device shall be provided with the appropriate factory fabricated cable for interfacing the communications module with the associated Ethernet device.

2.10 ACCESSORIES

A. Devices shall be factory installed in controller enclosure, unless otherwise indicated.


C. Stop and Lockout Push-Button Station: Momentary-break, push-button station with a factory-applied hasp arranged so padlock can be used to lock push button in depressed position with control circuit open.

D. Control Relays: Auxiliary and adjustable time-delay relays.

E. Elapsed Time Meters: Heavy duty, LED type, with digital readout in hours.

F. Surge Protection Devices: Where indicated on drawings, motor control centers shall include surge protective devices factory-installed meeting the following requirements:
   1. Comply with UL 1449, Type 2. Provide disconnecting means.
   2. Peak Surge Current Rating: The minimum single-pulse surge current withstand rating per phase shall not be less than 240 kA. The peak surge current rating shall be the arithmetic sum of the ratings of the individual MOVs in a given mode.
   3. Protection modes and UL 1449 VPR for grounded wye circuits with 480Y/277 V, three-phase, four-wire circuits shall not exceed the following:
      a. Line to Neutral: 1200 V.
      b. Line to Ground: 1200 V.
      c. Line to Line: 2000 V
   4. SCCR: Equal or exceed the short circuit current rating of the motor control center.
   5. Inominal Rating: 20 kA.

G. Multifunction Digital-Metering Monitor: UL-listed or –recognized, microprocessor-based unit suitable for three-or-four-wire systems and with the following features:
   1. Inputs from sensors or 5-A current-transformer secondaries, and potential terminals rated to 600 V.
   2. Switch-selectable digital display of the following:
      a. Phase Currents, Each Phase: Plus or minus 1 percent.
      b. Phase-to-Phase Voltages, Three Phase: Plus or minus 1 percent.
      c. Phase-to-Neutral Voltages, Three Phase: Plus or minus 1 percent.
      d. Three-Phase Real Power: Plus or minus 2 percent.
      e. Three-Phase Reactive Power: Plus or minus 2 percent.
      f. Power Factor: Plus or minus 2 percent
      g. Frequency: Plus or minus 0.5 percent.
      h. Integrated Demand with Demand Interval Selectable from 5 to 60 Minutes: Plus or minus 2 percent.
   3. Mounting: Display and control unit flush or semiflush mounted in instrument compartment door.
   4. Unit to have ethernet port for connection to external monitoring system.
H. Current-Sensing, Phase-Failure Relays: Solid-state sensing circuit with isolated output contacts for hard-wired connection; arranged to operate on phase failure, phase reversal, current unbalance of from 30 to 40 percent, or loss of supply voltage; with adjustable response delay.

2.11 FACTORY FINISHES

A. Finish: manufacturer’s standard paint applied to factory-assembled and –tested, motor-control centers before shipping.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and surfaces to receive motor-control centers for compliance with requirements, installation tolerances and other conditions affecting performance.

1. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 APPLICATIONS

A. Select features of each controller to coordinate with ratings and characteristics of supply circuit and motor; required control sequence; duty cycle of motor, controller, and load; and configuration of pilot device and control circuit affecting controller functions.

B. Select horsepower rating of controllers to suit motor controlled.

3.3 INSTALLATION

A. Anchor each motor-control center assembly to steel-channel sills arranged and sized according to manufacturer’s written instructions. Attach by bolting. Level and grout sills flush with motor-control center mounting surface.

B. Install motor-control centers on concrete bases.

3.4 CONCRETE BASES

A. Coordinate size and location of concrete bases. Verify structural requirements with structural engineer.

3.5 IDENTIFICATION

A. Identify motor-control center, motor-control center components, and control wiring according to Division 26 Section "Identification for Electrical Systems."

3.6 CONTROL WIRING INSTALLATION

A. Install wiring between motor-control devices according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

B. Bundle, train, and support wiring in enclosures.

C. Connect hand-off-automatic switch and other automatic-control devices where applicable.
3.7 CONNECTIONS

A. Conduit installation requirements are specified in other Division 26 Sections. Drawings indicate general arrangement of conduit, fittings and specialties.

B. Ground equipment according to Division 26 Section “Grounding and Bonding for Electrical Systems.”

3.8 FIELD QUALITY CONTROL

A. Prepare for acceptance tests as follows:
   1. Test insulation resistance for each motor-control center element, bus, component, connecting supply, feeder and control circuit.
   2. Test continuity of each circuit.

B. Manufacturer’s Field Service: Engage a factory-authorized service representative to perform the following:
   1. Inspect controllers, wiring, components, connections, and equipment installation. Test and adjust controllers, components and equipment.
   2. To assist in field testing of equipment including pretesting and adjusting of solid-state controllers.

C. Perform the following field test and inspections and prepare test reports:
   1. Perform each electrical test and visual and mechanical inspection tests, stated in NETA ATS “Motor Control Centers.” Certify compliance with test parameters.
   2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

3.9 ADJUSTING

A. Set field-adjustable switches and circuit-breaker trip ranges.

3.10 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner’s maintenance personnel to adjust, operate and maintain components of motor-control centers including solid-state controllers and variable frequency controllers.

END OF SECTION
SECTION 26 28 13 - FUSES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections apply to this Section.

1.2 SUMMARY

A. Section Includes:
1. Cartridge fuses rated 600-V ac and less for use in control circuits, enclosed switches, controllers and motor-control centers.

1.3 SUBMITTALS

A. Product Data: For each type of product indicated. Include construction details, material, dimensions, descriptions of individual components and finishes for spare-fuse cabinets. Include the following for each fuse type indicated:
1. Ambient Temperature Adjustment Information: If ratings of fuses have been adjusted to accommodate ambient temperatures, provide list of fuses with adjusted ratings.
   a. For each fuse having adjusted ratings, include location of fuse, original fuse rating, local ambient temperature, and adjusted fuse rating.
   b. Provide manufacturer’s technical data on which ambient temperature adjustment calculations are based.
2. Dimensions and manufacturer’s technical data on features, performance, electrical characteristics and ratings.

B. Operation and Maintenance Data: For fuses to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section “Operation and Maintenance Data,” include the following:
1. Ambient temperature adjustment information.
2. Current-limitation curves for fuses with current-limiting characteristics.

1.4 QUALITY ASSURANCE

A. Source Limitations: Obtain fuses, for use within a specific product or circuit, from single source from single manufacturer.

B. Electrical Components, Devices and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency and marked for intended location and application.

C. Comply with NEMA FU 1 for cartridge fuses.

D. Comply with NFPA 70.

1.5 COORDINATION

A. Coordinate fuse ratings with utilization equipment nameplate limitations of maximum fuse size and with system short-circuit current levels.
1.6 EXTRA MATERIALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than two of each size and type.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Cooper Bussmann, Inc.
   2. Edison Fuse, Inc.
   3. Ferraz Shawmut, Inc.
   4. Littelfuse, Inc.

2.2 CARTRIDGE FUSES

A. Characteristics: NEMA FU 1, nonrenewable cartridge fuses with voltage ratings consistent with circuit voltages.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine fuses before installation. Reject fuses that are moisture damaged or physically damaged.

B. Examine holders to receive fuses for compliance with installation tolerances and other conditions affecting performance, such as rejection features.

C. Examine utilization equipment nameplates and installation instructions. Install fuses of sizes and with characteristics appropriate for each piece of equipment.

D. Evaluate ambient temperatures to determine if fuse rating adjustment factors must be applied to fuse ratings.

E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 FUSE APPLICATIONS

A. Cartridge Fuses:
   1. Feeders: Class L, fast acting Class RK1 or fast acting Class RK5.
   2. Motor Branch Circuits: Class RK1, time delay.
   3. Control Circuits: Class CC, fast acting.

3.3 INSTALLATION

A. Install fuses in fusible devices. Arrange fuses so rating information is readable without removing fuse.
3.4 IDENTIFICATION

A. Install labels complying with requirements for identification specified in Division 26 Section “Identification for Electrical Systems” and indicating fuse replacement information on inside door of each fused switch and adjacent to each fuse block, socket and holder.

END OF SECTION
PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:
   1. Fusible switches.
   2. Nonfusible switches.
   3. Molded-case circuit breakers (MCCBs).
   5. Enclosures.

1.3 SUBMITTALS

A. Product Data: For each type of enclosed switch, circuit breaker, accessory, and component indicated. Include dimensioned elevations, sections, weights and manufacturers’ technical data on features, performance, electrical characteristics, ratings, accessories and finishes.
   1. Enclosure types and details for all types indicated, including NEMA 250, Type 1.
   2. Current and voltage ratings.
   3. Short-circuit current ratings (interrupting and withstand, as appropriate).
   4. Include evidence of Nationally Recognized Testing Laboratory listing for series rating of installed devices.
   5. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices, accessories, and auxiliary components.

B. Shop Drawings: For enclosed switches and circuit breakers. Include plans, elevations, sections, details, and attachments to other work.
   1. Wiring Diagrams: for power, signal, and control wiring.

C. Qualification Data: For qualified testing agency.

D. Field quality-control reports.
   1. Test procedures used.
   2. Test results that comply with requirements.
   3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.

E. Operation and Maintenance Data: For enclosed switches and circuit breakers to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section “Operation and Maintenance Data,” include the following:
   1. Manufacturer’s written instructions for testing and adjusting enclosed switches and circuit breakers.

1.4 QUALITY ASSURANCE

A. Source Limitations: Obtain enclosed switches and circuit breakers, overcurrent protective devices, components, and accessories, within same product category from single manufacturer.
B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. Comply with NFPA 70.

1.5 COORDINATION

A. Coordinate layout and installation of switches, circuit breakers, and components with equipment served and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

1.6 EXTRA MATERIALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.
   2. Fuse Pullers: Two for each size and type.

PART 2 - PRODUCTS

2.1 FUSIBLE SWITCHES

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the work include, but are not limited to, the following:
   1. Square D; a brand of Schneider Electric.

B. Type HD, Heavy Duty, Single Throw, 600-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, with clips or bolt pads to accommodate fuses, lockable handle with capability to accept three 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; labeled for copper and aluminum neutral conductors.
   3. Class R Fuse Kit: Provides rejection of other fuse types when Class R fuses are specified.
   4. Lugs: Mechanical type, suitable for number, size and conductor material.

2.2 NONFUSIBLE SWITCHES

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the work include, but are not limited to, the following:
   1. Square D; a brand of Schneider Electric.

B. Type HD, Heavy Duty, Single Throw, 600-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept three 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; labeled for copper and aluminum neutral conductors.
2.3 MOLED-CASE CIRCUIT BREAKERS

A. Manufacturers: subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
   1. Square D; a brand of Schneider Electric.

B. General Requirements: Comply with UL 489, NEMA AB 1, and NEMA AB 3, with interrupting capacity to comply with available fault currents.


D. Features and Accessories:
   1. Standard frame sizes, trip ratings and number of poles.

2.4 MOLED-CASE SWITCHES

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include:
   1. Square D; a brand of Schneider Electric.

B. General Requirements: MCCB with fixed, high-set instantaneous trip only, and short-circuit withstand rating equal to equivalent breaker frame size interrupting rating.

C. Features and Accessories:
   1. Standard frame sizes and number of poles.

2.5 ENCLOSURES

A. Enclosed Switches and Circuit Breakers: NEMA AB 1, NEMA KS 1, NEMA 250, and UL 50, to comply with environmental conditions at installed location.

   1. Indoor Clean and Dry Locations: NEMA 1
   2. Outdoors: NEMA 4X Stainless Steel
   3. Indoor Wet or Corrosive Locations: NEMA 4X Stainless Steel

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine elements and surfaces to receive enclosed switches and circuit breakers for compliance with installation tolerances and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install individual wall-mounted switches and circuit breakers with tops at uniform height unless otherwise indicated.

B. Installation height of disconnect devices shall be in conformance with NFPA 70, Article 240.24.

C. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts form enclosures and components.
D. Furnish and install fuses in fusible devices.

E. Comply with NECA 1.

3.3 IDENTIFICATION

A. Comply with requirements in Division 26 Section “Identification for Electrical Systems.”
   1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
   2. Label each enclosure with engraved metal or laminated-plastic nameplate.

3.4 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Acceptance Testing Preparation:
   1. Test insulation resistance for each enclosed switch and circuit breaker, component, connecting supply, feeder, and control circuit.
   2. Test continuity of each circuit.

C. Tests and Inspections:
   1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
   2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
   3. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.

D. Enclosed switches and circuit breakers will be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection reports, including a certified report that identifies enclosed switches and circuit breakers. Include notation of deficiencies detected, remedial action taken and observations after remedial action.

3.5 ADJUSTING

A. Adjust moving parts and operable components to function smoothly, and lubricate as recommended by manufacturer.

END OF SECTION
SECTION 26 29 13 - ENCLOSED CONTROLLERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes the following enclosed controllers rated 600 V and less:
   1. Full-voltage magnetic.

1.3 DEFINITIONS

A. CPT: Control power transformer.

B. MCCB: Molded-case circuit breaker.

C. MCP: Motor circuit protector.

D. N.C.: Normally closed.

E. N.O.: Normally open.

F. NRTL: Nationally Recognized Testing Laboratory

G. OCPD: Overcurrent protective device.

H. SCR: Silicon-controlled rectifier.

1.4 SUBMITTALS

A. Product Data: For each type of enclosed controller. Include manufacturer’s technical data on features, performance, electrical characteristics, ratings, and enclosure types and finishes.

B. Shop Drawings: for each enclosed controller: Include dimensioned plans, elevations, sections, details, and required clearances and service spaces around controller enclosures.
   1. Show tabulations of the following:
      a. Each installed unit’s type and details.
      b. Factory-installed devices.
      c. Nameplate legends.
      d. Short-circuit current rating of integrated unit.
      e. Listed and labeled for integrated short-circuit current (withstand) rating of OCPDs in combination controllers by an NRTL acceptable to authorities having jurisdiction.
      f. Features, characteristics, ratings and factory settings of individual OCPDs in combination controllers.
   2. Wiring Diagrams: For power, signal, and control wiring.

C. Field quality-control reports.

D. Operation and Maintenance Data: For enclosed controllers to include in emergency, operation and maintenance manuals. In addition to items specified in Division 01 Section “Operation and Maintenance Data,” include the following:
1. Routing maintenance requirements for enclosed controllers and installed components.
2. Manufacturer’s written instructions for testing and adjusting circuit breaker and MCP trip settings.
3. Manufacturer’s written instructions for setting field-adjustable overload relays.

E. Load-Current and Overload-Relay Heater List: Compile after motors have been installed, and arrange to demonstrate that selection of heaters suits actual motor nameplate full-load currents.

F. Load-Current and List of Adjustable Overload Relays: Compile after motors have been installed, and arrange to demonstrate that switch settings for motor running overload protection suit actual motors to be protected.

1.5 QUALITY ASSURANCE

A. Electrical Components, Devices and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Comply with NFPA 70.

1.6 DELIVERY, STORAGE AND HANDLING

A. Store enclosed controllers indoors in clean, dry space with uniform temperature to prevent condensation. Protect enclosed controllers from exposure to dirt, fumes, water, corrosive substances, and physical damage.

B. If stored in areas subject to weather, cover enclosed controllers to protect them from weather, dirt, dust, corrosive substances, and physical damage. Remove loose packing and flammable materials from inside controllers; install temporary electric heating, with at least 250 W per controller.

1.7 COORDINATION

A. Coordinate layout and installation of enclosed controllers with other construction including conduit, piping, equipment and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

PART 2 - PRODUCTS

2.1 MANUFACTURED UNITS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Schneider Electric, Square D.

2.2 FULL-VOLTAGE CONTROLLERS

A. General Requirements for Full-voltage Controllers: comply with NEMA ICS 2, general purpose, Class A.
   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.

B. Combination Magnetic Controller: Factory-assembled combination of magnetic controller, OCPD, and disconnecting means.
   1. MCP Disconnecting Means:
a. UL 489, NEMA AB 1, and NEMA AB 3, with interrupting capacity to comply with available fault currents, instantaneous-only circuit breaker with front-mounted, field-adjustable, short-circuit trip coordinated with motor locked-rotor amperes.

b. Lockable Handle: Accepts three padlocks and interlocks with cover in closed position.

c. Auxiliary NO/NC contact that operates to indicate “ON” or “OFF”.

C. Overloads: Solid state type, electronic design with a 5:1 adjustment range, current based measurement protection, thermal memory, integrated I/O points, and enhanced phase loss protection.

2.3 ENCLOSURES

A. Enclosed Controllers: NEMA ICS 6, to comply with environmental conditions at installed location, constructed of stainless steel unless otherwise indicated on the drawings.

2.4 ACCESSORIES

A. General Requirements for Control Circuit and Pilot Devices: NEMA ICS 5; factory installed in controller enclosure cover unless otherwise indicated.

1. Push buttons, Pilot Lights and Selector Switches: Heavy-duty, oil tight type.
   a. Push Buttons: Unguarded types; as indicated.
   b. Pilot Lights: LED types; colors as indicated; push to test.
   c. Selector Switches: Rotary type.

2. Elapsed Time Meters: Heavy duty with digital readout in hours.

B. Control Relays: Auxiliary and adjustable solid-state time-delay relays.


PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and surfaces to receive enclosed controllers, with Installer present, for compliance with requirements and other conditions affecting performance of the Work.

B. Examine enclosed controllers before installation. Reject enclosed controllers that are wet, moisture damaged, or mold damaged.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Wall-Mounted Controllers: Install enclosed controllers on walls with tops at uniform height unless otherwise indicated, and by bolting units to wall or mounting on lightweight structural-steel channels bolted to wall. For controllers not at walls, provide freestanding racks complying with Division 16 Section “Hangers and Supports for Electrical Systems.”

B. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.

C. Install fuses in each fusible-switch enclosed controller.
D. Install fuses in control circuits if not factory installed. Comply with requirements in Division 26 Section “Fuses.”

E. Install, connect and fuse thermal-protector monitoring relays furnished with motor-driven equipment.

F. Comply with NECA 1.

3.3 IDENTIFICATION

A. Identify enclosed controllers, components and control wiring. Comply with requirements for identification specified in Division 26 Section “Identification for Electrical Systems.”
   1. Identify field-installed conductors, interconnecting wiring and components; provide warning signs.
   2. Label each enclosure with engraved nameplate.
   3. Label each enclosure-mounted control and pilot device.

3.4 CONTROL WIRING INSTALLATION

A. Install wiring between enclosed controllers and remote devices. Comply with requirements in Division 26 Section “Low Voltage Electrical Power Conductors and Cables.”

B. Bundle, train, and support wiring in enclosures.

C. Connect selector switches and other automatic-control selection devices where applicable.

3.5 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Acceptance Testing Preparation:
   1. Test insulation resistance for each enclosed controller, component, connecting supply, feeder and control circuit.
   2. Test continuity of each circuit.

C. Tests and Inspections:
   1. Inspect controllers, wiring, components, connections, and equipment installation. Test and adjust controllers, components and equipment.
   2. Test insulation resistance for each enclosed-controller element, component, connecting motor supply, feeder and control circuits.
   3. Test continuity of each circuit.
   4. Verify that voltages at controller locations are within plus or minus 10 percent of motor nameplate rated voltages. If outside this range for any motor, notify Engineer before starting the motor(s).
   5. Test each motor for proper phase rotation.
   7. Correct malfunctioning units on-site, where possible and retest to demonstrate compliance; otherwise, replace with new units and retest.
   8. Test and adjust controls, remote monitoring and safeties. Replace damaged and malfunctioning controls and equipment.

D. Enclosed controllers will be considered defective if they do not pass tests and inspections.
E. Prepare test and inspection reports including a certified report that identifies enclosed controllers and that describes scanning results. Include notation of deficiencies detected, remedial action taken and observations after remedial action.

3.6 ADJUSTING

A. Set field-adjustable switches, auxiliary relays, time-delay relays, timers, and overload-relay pickup and trip ranges.

B. Adjust overload-relay heaters or settings if power factor correction capacitors are connected to the load side of the overload relays.

C. Adjust the trip settings of MCPs and thermal-magnetic circuit breakers with adjustable instantaneous trip elements. Initially adjust to six times the motor nameplate full-load ampere ratings and attempt to start motors several times, allowing for motor cool down between starts. If tripping occurs on motor inrush, adjust settings in increments until motors start without tripping. Do not exceed eight times the motor full-load amperes (or 11 times for NEMA Premium Efficient motors if required). Where these maximum settings do not allow starting of a motor, notify Engineer before increasing settings.

3.7 PROTECTION

A. Temporary Heating: Apply temporary heat to maintain temperature according to manufacturer’s written instructions until enclosed controllers are ready to be energized and placed into service.

B. Replace controllers whose interiors have been exposed to water or other liquids prior to Substantial Completion.

END OF SECTION
SECTION 26 29 23 - VARIABLE-FREQUENCY MOTOR CONTROLLERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes separately enclosed, pre-assembled, combination VFCs, rated 600 V and less, for speed control of three-phase, squirrel-cage induction motors. Specifically, this section applies to the Oxidation Ditch Aerator VFDs.

1.2 QUALIFICATIONS

A. Manufacturer
1. The manufacturer shall have a minimum of 15 years experience in the manufacture of variable frequency motor controllers.

B. Support
1. The manufacturer shall maintain factory trained and authorized service facilities within 100 miles of the project and shall have a demonstrated record of service for at least the previous ten years.
2. Support personnel are to be direct employees of the manufacturer.
3. The manufacturer shall provide all required start-up and training services.

1.3 DEFINITIONS

A. CE: Conformite Europeene (European Compliance).
B. CPT: Control power transformer.
C. EMI: Electromagnetic interference.
D. IGBT: Insulated-gate bipolar transistor.
E. LED: Light-emitting diode.
F. MCP: Motor-circuit protector.
G. NC: Normally closed.
H. NO: Normally open.
I. OCPD: Overcurrent protective device.
J. PCC: Point of common coupling.
K. PID: Control action, proportional plus integral plus derivative.
L. PWM: Pulse-width modulated.
M. RFI: Radio-frequency interference.
N. TDD: Total demand (harmonic current) distortion.
O. THD(V): Total harmonic voltage demand.
1.4 PERFORMANCE REQUIREMENTS

A. Seismic Performance: VFCs shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
   1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

1.5 SUBMITTALS

A. Product Data: For each type and rating of VFC indicated. Include features, performance, electrical ratings, operating characteristics, shipping and operating weights, and furnished specialties and accessories.

B. Shop Drawings: For each VFC indicated. Include dimensioned plans, elevations, and sections; and conduit entry locations and sizes, mounting arrangements, and details, including required clearances and service space around equipment.
   1. Show tabulations of installed devices, equipment features, and ratings. Include the following:
      a. Each installed unit's type and details.
      b. Factory-installed devices.
      c. Enclosure types and details.
      d. Nameplate legends.
      e. Short-circuit current (withstand) rating of enclosed unit.
      f. Features, characteristics, ratings, and factory settings of each VFC and installed devices.
      g. Specified modifications.
   2. Schematic and Connection Wiring Diagrams: For power, signal, and control wiring.

C. Coordination Drawings: Floor plans, drawn to scale, showing dimensioned layout, required working clearances, and required area above and around VFCs. Show VFC layout and relationships between electrical components and adjacent structural and mechanical elements. Show support locations, type of support, and weight on each support. Indicate field measurements.

D. Seismic Qualification Certificates: For VFCs, accessories, and components, from manufacturer.
   1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
   2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
   3. Detailed description of equipment anchorage devices on which the certification is based, and their installation requirements.

E. Product Certificates: For each VFC, from manufacturer.

F. Operation and Maintenance Data: For VFCs to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:
   1. Manufacturer's written instructions for testing and adjusting thermal-magnetic circuit breaker and MCP trip settings.
   2. Manufacturer's written instructions for setting field-adjustable overload relays.

P. VFC: Variable frequency motor controller.

Q. VFD: Variable frequency drive.
3. Manufacturer's written instructions for testing, adjusting, and reprogramming microprocessor control modules.
4. Manufacturer's written instructions for setting field-adjustable timers, controls, and status and alarm points.

G. Load-Current and List of Settings of Adjustable Overload Relays: Compile after motors have been installed and arrange to demonstrate that switch settings for motor-running overload protection suit actual motors to be protected.

1.6 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Comply with NFPA 70.

C. IEEE Compliance: Fabricate and test VFC according to IEEE 344.

1.7 DELIVERY, STORAGE, AND HANDLING

A. If stored in space that is not permanently enclosed and air conditioned, remove loose packing and flammable materials from inside controllers and install temporary electric heating, with at least 250 W per controller and connect factory-installed space heaters to temporary electrical service.

1.8 PROJECT CONDITIONS

A. Environmental Limitations: Rate equipment for continuous operation, capable of driving full load without derating, under the following conditions unless otherwise indicated:
   1. Operating Ambient Temperature Range: 32 degrees F to 104 deg F.
   2. Storage Ambient Temperature Range: -40 degrees F to 158 degrees F.
   3. Relative Humidity Range: 5% to 95% non-condensing.
   4. Altitude: Up to 3,300 feet.

B. Product Selection for Restricted Space: Drawings indicate maximum dimensions for VFCs, including clearances between VFCs, and adjacent surfaces and other items.

1.9 COORDINATION

A. Coordinate features of motors, load characteristics, installed units, and accessory devices to be compatible with the following:
   1. Torque, speed, and horsepower requirements of the load.
   2. Ratings and characteristics of supply circuit and required control sequence.
   3. Ambient and environmental conditions of installation location.

B. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases.

C. Coordinate sizes and locations of roof curbs, equipment supports, and roof penetrations with actual equipment provided.

1.10 WARRANTY

A. Manufacturer's standard form in which manufacturer agrees to repair or replace VFCs that fail in materials or workmanship within specified warranty period.
1. Warranty Period: 1 year from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 VARIABLE FREQUENCY DRIVES

A. Products in this section shall be low harmonic type, as manufactured by the following:

B. General Requirements for VFCs: Comply with NEMA ICS 7, NEMA ICS 61800-2, and UL 508C.

C. Application: As indicated on the plans.

D. VFC Description: Variable-frequency power converter (rectifier, dc bus, and IGBT, PWM inverter) factory packaged in an enclosure, with integral disconnecting means and overcurrent and overload protection; listed and labeled by an NRTL as a complete unit; arranged to provide self-protection, protection, and variable-speed control of a three-phase induction motor by adjusting output voltage and frequency.
   1. Units suitable for operation of NEMA MG 1, Design A and Design B motors as defined by NEMA MG 1, Section IV, Part 30, "Application Considerations for Constant Speed Motors Used on a Sinusoidal Bus with Harmonic Content and General Purpose Motors Used with Adjustable-Voltage or Adjustable-Frequency Controls or Both."
   2. Units suitable for operation of inverter-duty motors as defined by NEMA MG 1, Section IV, Part 31, "Definite-Purpose Inverter-Fed Polyphase Motors."
   3. Listed and labeled for integrated short-circuit current (withstand) rating by an NRTL acceptable to authorities having jurisdiction.

E. Output Rating: Three-phase; 10 to 60 Hz, with voltage proportional to frequency throughout voltage range; maximum voltage equals input voltage.

F. Unit Operating Requirements:
   1. The VFC shall accept nominal plant power of 480 VAC at 60 Hertz.
   2. Input AC Voltage Tolerance: Plus 10 and minus 15 percent of VFC input voltage rating.
   3. Input AC Voltage Unbalance: Not exceeding 5 percent.
   4. Input Frequency Tolerance: Plus or minus 3 percent of VFC frequency rating.
   5. Minimum Efficiency: 97 percent at 60 Hz, full load.
   6. Minimum Displacement Primary-Side Power Factor: 95 percent under any load or speed condition.
   7. Minimum Short-Circuit Current (Withstand) Rating: 42kA.
   9. Overload Capability: 1.1 times the base load current for 60 seconds; minimum of 1.5 times the base load current for three seconds.
   10. Starting Torque: Minimum 100 percent of rated torque from 3 to 60 Hz.
   11. Speed Regulation: Plus or minus 5 percent.
   12. Stop Modes: Programmable; includes ramp, coast, fast, and dc injection braking.

G. Isolated Control Interface: Allows VFCs to follow remote-control signal over a minimum 40:1 speed range.
   1. Signal: Electrical, 4 to 20 mA DC.

H. Internal Adjustability Capabilities:
   1. Minimum Speed: 5 to 25 percent of maximum rpm.
   2. Maximum Speed: 80 to 100 percent of maximum rpm.
   3. Acceleration: 0.1 to 999.9 seconds.
4. Deceleration: 0.1 to 999.9 seconds.
5. Current Limit: 30 to minimum of 150 percent of maximum rating.

I. Self-Protection and Reliability Features:
   1. Input transient protection by means of surge suppressors to provide three-phase protection against damage from supply voltage surges 10 percent or more above nominal line voltage.
   2. Loss of Input Signal Protection: Selectable response strategy, including speed default to a percent of the most recent speed, a preset speed, or stop; with alarm.
   4. Inverter overcurrent trips.
   5. VFC and Motor Overload/Overtemperature Protection: Microprocessor-based thermal protection system for monitoring VFCs and motor thermal characteristics, and for providing VFC overtemperature and motor overload alarm and trip; settings selectable via the keypad; NRTL approved.
   6. Critical frequency rejection, with three selectable and adjustable deadbands.
   7. Instantaneous line-to-line and line-to-ground overcurrent trips.
   10. Short-circuit protection.
   11. Motor overtemperature fault.

J. Automatic Reset/Restart: Attempt three restarts after drive fault and before shutting down for manual reset or fault correction; adjustable delay time between restart attempts.

K. Power-Interruption Protection: To prevent motor from re-energizing after a power interruption until motor has stopped.

L. Bidirectional Autospeed Search: Capable of starting VFC into rotating loads spinning in either direction and returning motor to set speed in proper direction, without causing damage to drive, motor, or load.

M. Torque Boost: Automatically varies starting and continuous torque to at least 1.5 times the minimum torque to ensure high-starting torque and increased torque at slow speeds.

N. Motor Temperature Compensation at Slow Speeds: Adjustable current fall-back based on output frequency for temperature protection of self-cooled, fan-ventilated motors at slow speeds.

O. Integral Input Disconnecting Means and OCPD: NEMA AB 1, thermal-magnetic circuit breaker with pad-lockable, door-mounted handle mechanism.
   1. Disconnect Rating: Not less than 115 percent of NFPA 70 motor full-load current rating or VFC input current rating, whichever is larger.
   2. Auxiliary Contacts: NO/NC, arranged to activate before switch blades open.
   3. Auxiliary contacts "a" and "b" arranged to activate with circuit-breaker handle.
   4. NC and NO alarm contact that operates only when circuit breaker has tripped.

P. Controls and Indication
   2. Status Lights:
      a. VFD Running.
      b. VFD Fault.
      c. Other indication lights as indicated on the contract drawing schematics.
   3. Control Switches:
      a. Local/Off/Remote selector switch.
b. Other switches as indicated on the contract drawing schematics.

4. Control Signal Interfaces:
   a. Electric Input Signal Interface:
      1) A minimum of two programmable analog inputs: 4 to 20 mA DC.
      2) A minimum of six multifunction programmable digital inputs.
   b. Output Signal Interface: A minimum of one programmable analog output signal(s) (4 to 20 mA DC), which can be configured for any of the following:
      1) Output frequency (Hz).
      2) Output current (load).
      3) DC-link voltage (V dc).
      4) Motor torque (percent).
      5) Motor speed (rpm).
      6) Set point frequency (Hz).
   c. Remote Indication Interface: A minimum of two programmable dry-circuit relay outputs (120-V ac, 1 A) for remote indication of the following:
      1) Motor running.
      2) Set point speed reached.
      3) Fault and warning indication (overtemperature or overcurrent).
   d. Communication: Provide Ethernet/IP communication support.
   e. Other control signal interfaces as indicated on the contract drawing schematics.

Q. Line Conditioning and Filtering
   1. Input Line Conditioning
      a. Provide 3-level Active Front End components to limit TDD and THD(V) at the defined PCC per IEEE 519.
   2. Output Filtering
      a. For motor lead lengths 150-500 feet, provide dv/dt output filter, TCI V1k or equal.
      b. For motor lead lengths greater than 500 feet, provide motor sine wave filter, TCI MotorShield or equal.

R. Enclosures
   1. VFC Enclosures: NEMA 250, to comply with environmental conditions at installed location.
      a. Dry and Clean Indoor Locations: Type 1.

S. Accessories
   1. General Requirements for Control-Circuit and Pilot Devices: NEMA ICS 5; factory installed in VFC enclosure cover unless otherwise indicated.
         1) Push Buttons: Recessed types; maintained or momentary as required.
         2) Pilot Lights: LED types; push to test.
         3) Selector Switches: Rotary type.
         4) Stop and Lockout Push-Button Station: Momentary-break, push-button station with a factory-applied hasp arranged so padlock can be used to lock push button in depressed position with control circuit open.
   2. Control Relays: Auxiliary and adjustable solid-state time-delay relays.
   4. Cooling Fan and Exhaust System: For NEMA 250, Type 1; UL 508 component recognized: Supply fan, with composite stainless steel intake and exhaust grills and filters; 120 -V ac; obtained from integral CPT.
   5. Spare control-wiring terminal blocks; wired.
PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas, surfaces, and substrates to receive VFCs, with Installer present, for compliance with requirements for installation tolerances, and other conditions affecting performance.

B. Examine VFC before installation. Reject VFCs that are wet, moisture damaged, or mold damaged.

C. Examine roughing-in for conduit systems to verify actual locations of conduit connections before VFC installation.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Coordinate layout and installation of VFCs with other construction including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

B. Floor-Mounting Controllers: Install VFCs on 4-inch nominal thickness concrete base. Comply with requirements for concrete base specified in Division 03 Section "Cast-in-Place Concrete or Miscellaneous Cast-in-Place Concrete."

   1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of concrete base.
   2. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
   3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
   4. Install anchor bolts to elevations required for proper attachment to supported equipment.

C. Seismic Bracing: Comply with requirements specified in Division 26 Section "Vibration and Seismic Controls for Electrical Systems."

D. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.

E. Install fuses in each fusible-switch.

F. Install fuses in control circuits if not factory installed. Comply with requirements in Division 26 Section "Fuses."

G. Install, connect, and fuse thermal-protector monitoring relays furnished with motor-driven equipment.

H. Comply with NECA 1.

3.3 IDENTIFICATION

A. Identify VFCs, components, and control wiring. Comply with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

   1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
2. Label each VFC with engraved nameplate.
3. Label each enclosure-mounted control and pilot device.

B. Operating Instructions: Frame printed operating instructions for VFCs, including control sequences and emergency procedures. Fabricate frame of finished metal, and cover instructions with clear acrylic plastic. Mount on front of VFC units.

3.4 CONTROL WIRING INSTALLATION

A. Install wiring between VFCs and remote devices and facility's central-control system. Comply with requirements in Division 26 Section "Low Voltage Electrical Power Conductors and Cables."

B. Bundle, train, and support wiring in enclosures.

C. Connect selector switches and other automatic control devices where applicable.
   1. Connect selector switches to bypass only those manual- and automatic control devices that have no safety functions when switches are in manual-control position.
   2. Connect selector switches with control circuit in both manual and automatic positions for safety-type control devices such as low- and high-pressure cutouts, high-temperature cutouts, and motor overload protectors.

3.5 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.
   1. Complete installation and startup checks according to manufacturer's written instructions.

3.6 ADJUSTING

A. Program microprocessors for required operational sequences, status indications, alarms, event recording, and display features. Clear events memory after final acceptance testing and prior to Substantial Completion.

B. Set field-adjustable switches, auxiliary relays, time-delay relays, timers, and overload-relay pickup and trip ranges.

C. Set field-adjustable circuit-breaker trip ranges as recommended by the manufacturer.

3.7 PROTECTION

A. Temporary Heating: Apply temporary heat to maintain temperature according to manufacturer's written instructions until controllers are ready to be energized and placed into service.

B. Replace VFCs whose interiors have been exposed to water or other liquids prior to Substantial Completion.

3.8 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, reprogram, and maintain VFCs.

END OF SECTION
SECTION 26 41 13 - LIGHTNING PROTECTION FOR STRUCTURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes lightning protection for building site components.

1.3 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Shop Drawings: for air terminals and mounting accessories.
   1. Layout of the lightning protection system, along with details of the components to be used in the installation.
   2. Include indications for use of raceway, data on how concealment requirements will be met, and calculations required by NFPA 780 for bonding of grounded and isolated metal bodies.

C. Qualification Data: For qualified Installer and manufacturer. Include data on listing or certification by UL.

D. Certification, signed by Contractor, that roof adhesive is approved by manufacturer of roofing material.

E. Field quality-control reports.

F. Other Informational Submittals: Plans showing dimensioned as-built locations of grounding features, including the following:
   1. Ground rods.
   2. Ground loop conductor.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: Certified by UL or LPI as a Master Installer/Designer, trained and approved for installation of units required for this Project.

B. Electrical components, Devices and Accessories: Listed and labeled as defined in NFPA 780, “Definitions” Article.

1.5 COORDINATION

A. Coordinate installation of lightning protection with installation of other building systems and components, including electrical wiring, supporting structures and building materials, metal bodies requiring bonding to lightning protection components, and building finishes.

B. Coordinate installation of air terminals attached to roof systems with roofing manufacturer and Installer.

C. Flashings of through-roof assemblies shall comply with roofing manufacturer’s specifications.
PART 2 - PRODUCTS

2.1 LIGHTNING PROTECTION SYSTEM COMPONENTS

A. Comply with UL 96 and NFPA 780.

B. Roof-Mounted Air Terminals: NFPA 780, Class I copper unless otherwise indicated.
   1. Manufacturers: subject to compliance with requirements, available manufacturers offering
      products that may be incorporated into the Work include, but are not limited to, the
      following:
      a. East Coast Lightning Equipment Inc.
      b. ERICO International Corporation.
      c. Harger.
      d. Heary Bros. Lightning Protection Co., Inc.
      e. Independent Protection Co.
      f. Preferred Lightning Protection.
      g. Robbins Lightning, Inc.
      h. Thompson Lightning Protection, Inc.
   2. Air Terminals More than 24 Inches Long: With brace attached to the terminal at not less
      than half the height of the terminal.
   3. Single-membrane, Roof-Mounted, Air Terminals: Designed specifically for single-
      membrane roof system materials.

C. Main and Bonding Conductors: Copper.

D. Ground Loop Conductor: The same size and type as the main conductor except tinned.

E. Ground Rods: Copper-clad steel; ¾ inch in diameter by 10 feet long.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install lightning protection components and systems according to UL 96A and NFPA 780.

B. Install conductors with direct paths from air terminals to ground connections. Avoid sharp
   bends.

C. Conceal the following conductors:
   1. System conductors.
   2. Down conductors.
   3. Interior conductors.
   4. Conductors within normal view of exterior locations at grade within 200 feet of building.

D. Cable Connections: Use crimped or bolted connections for all conductor splices and
   connections between conductors and other components. Use exothermic-welded connections in
   underground portions of the system.

E. Bond extremities of vertical metal bodies exceeding 60 feet in length of lightning protection
   components.

F. Ground Loop: Install ground-level, potential equalization conductor and extend around the
   perimeter of structure.
   1. Bury ground ring not less than 30 inches.
   2. Bond ground terminals to the ground loop.
3. Bond grounded building systems to the ground loop conductor within 12 feet of grade level.

G. Bond lightning protection components with intermediate-level interconnection loop conductors to grounded metal bodies of building at 60-foot intervals.

3.2 CORROSION PROTECTION

A. Do not combine materials that can form an electrolytic couple that will accelerate corrosion in the presence of moisture unless moisture is permanently excluded from junction of such materials.

B. Use conductors with protective coatings where conditions cause deterioration or corrosion of conductors.

3.3 FIELD QUALITY CONTROL

A. Notify Engineer at least 48 hours in advance of inspection before concealing lightning protection components.

END OF SECTION
SECTION 26 51 00 - INTERIOR LIGHTING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Interior lighting fixtures, lamps, and ballasts.
   2. Emergency lighting units.
   3. Exit signs.
   4. Lighting fixture supports.

1.2 DEFINITIONS

A. BF: Ballast factor.
B. CCT: Correlated color temperature.
C. CRI: Color-rendering index.
D. HID: High-intensity discharge.
E. Lumen: Measured output of lamp and luminaire, or both.
F. Luminaire: Complete lighting fixture, including ballast housing if provided.

1.3 SUBMITTALS

A. Product Data: For each type of lighting fixture, arranged in order of fixture designation. Include data on features, accessories, finishes and the following:
   1. Physical description of lighting fixture including dimensions.
   2. Emergency lighting units including battery and charger.
   3. Ballast, including BF.
   5. Life, output (lumens, CCT, and CRI) and energy-efficiency data for lamps.
   6. Photometric data and adjustment factors based on laboratory tests, complying with IESNA Lighting Measurements Testing & Calculation Guides, of each lighting fixture type. The adjustment factors shall be for lamps, ballasts and accessories identical to those indicated for the lighting fixture as applied in this Project.
      a. Manufacturer Certified Data: Photometric data shall be certified by a manufacturer’s laboratory with a current accreditation under the National Voluntary Laboratory Accreditation Program for Energy efficient Lighting Products.

B. Installation instructions.
C. Qualification Data: For qualified agencies providing photometric data for lighting fixtures.
D. Product Certificates: For each type of ballast for bi-level and dimmer-controlled fixtures, from manufacturer.
E. Field quality-control reports.
F. Operation and Maintenance Data: For lighting equipment and fixtures to include in emergency, operation and maintenance manuals.
   1. Provide a list of all lamp types used on Project; use ANSI and manufacturers’ codes.
G. Warranty: 12 months after project acceptance.

1.4 QUALITY ASSURANCE

A. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by manufacturer’s laboratories that are accredited under the National volunteer Laboratory Accreditation Program for Energy Efficient Lighting Products.

B. Electric Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency and marked for intended location and application.

C. Comply with NFPA 70.

1.5 COORDINATION

A. Coordinate layout and installation of lighting fixtures and suspension system with other construction that penetrates ceilings or is supported by them, including HVAC equipment, fire-suppression system and partition assemblies.

1.6 WARRANTY

A. Special Warranty for Emergency Lighting Batteries: Manufacturer’s standard form in which manufacturer of battery powered emergency lighting unit agrees to repair or replace components of rechargeable batteries that fail in materials or workmanship within specified warranty period.
   1. Warranty Period for Emergency Lighting Unit Batteries: 10 years from date of Substantial Completion. Full warranty shall apply for first year, and prorated warranty for the remaining nine years.
   2. Warranty Period for Emergency Fluorescent Ballast and Self-Powered Exit Sign Batteries: Seven years from date of Substantial Completion. Full warranty shall apply for first year, and prorated warranty for the remaining six years.

1.7 EXTRA MATERIALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Lamps: 10 for every 100 Insert quantity of each type and rating installed. Furnish at least one of each type.
   2. Plastic Diffusers and Lenses: One for every 100 of each type and rating installed. Furnish at least one of each type.
   3. Fluorescent-fixture-mounted, emergency battery pack: One for every 20 emergency lighting unit.
   4. Ballasts: One for every 100 of each type and rating installed. Furnish at least one of each type.
   5. Globes and Guards: One for every 20 of each type and rating installed. Furnish at least one of each type.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, product(s) indicated on Drawings.

B. Substitutions:
1. Provide complete literature for each luminaire substitution:
2. Submittals for substituted luminaires shall be sufficient for competent comparison of the proposed luminaire to the originally specified luminaire:
   a. Photometric data:
      1) IES file in standard IES format.
      2) Coefficient of utilization tables based on the IES zonal cavity system by an approved testing laboratory.
      3) Candlepower distribution curves.
      4) Average luminaire brightness.
      5) Lumen output charts.
      6) Power requirements in watts and volt-amperes.
   b. Calculations:
      1) Provide software generated calculations showing illuminance levels in footcandles and power usage in watts per square foot for each of the areas in which substitutions are proposed:
         a) Use surface reflectance values and luminaire light loss factors approved by the Engineer to perform all calculations.
3. Substitutions for specified luminaires will be evaluated upon quality of construction, light distribution, energy use, appearance, and maintenance.
4. Substitutions shall comply with all applicable building codes.

2.2 GENERAL REQUIREMENTS FOR LIGHTING FIXTURES AND COMPONENTS

A. Metal Parts: Free of burrs and sharp corners and edges.

B. Sheet Metal Components: Steel unless otherwise indicated. Form and support to prevent warping and sagging.

C. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions and designed to permit relamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position.

D. Diffusers and Globes:
   1. Acrylic Lighting Diffusers: 100 percent virgin acrylic plastic. High resistance to yellowing and other changes due to aging, exposure to heat and UV radiation.
      a. Lens thickness: At least 0.125 inch minimum unless otherwise indicated.
      b. UV stabilized.
   2. Glass: Annealed crystal glass unless otherwise indicated.

E. Factory-Applied Labels: Comply with UL 1598. Include recommended lamps and ballasts. Labels shall be located where they will be readily visible to service personnel, but not seen from normal viewing angles when lamps are in place.
   1. Label shall include the following lamp and ballast characteristics:
      a. “USE ONLY” and include specific lamp type.
      b. Lamp diameter code (T-4, T-5, T-8, T-12, etc), tube configuration (twin, quad, triple, etc), base type, and nominal wattage for fluorescent and compact fluorescent luminaires.
      c. Lamp type, wattage, bulb type (ED17, BD56, etc.) and coating (clear or coated) for HID luminaires.
      d. Start type (preheat, rapid start, instant start, etc) for fluorescent and compact fluorescent luminaires.
      e. ANSI ballast type (M98, M57, etc.) for HID luminaires.
      f. CCT and CRI for all luminaires.
2.3 BALLASTS FOR LINEAR FLUORESCENT LAMPS

A. General Requirements for Electronic Ballasts.
   1. Comply with UL 935 and with ANSI C82.11.
   2. Designed for type and quantity of lamps served.
   3. Ballasts shall be designed for full light output unless another BF, dimmer, or bi-level control is indicated.
   4. Sound Rating: Class A.
   5. Total Harmonic Distortion Rating: Less than 10 percent.
   7. Operating Frequency: 42 kHz or higher.
   8. BF: 0.88 insert value or higher.
   9. Power Factor: 0.95 or higher.

B. Electronic Programmed Start Ballasts for T5 and T8 Lamps: comply with ANSI C82.11 and the following:
   1. Lamp end-of-life detection and shutdown circuit for T5 diameter lamps.
   2. Automatic lamp starting after lamp replacement.

C. Electromagnetic Ballasts: Comply with ANSI C82.1; energy saving, high-power factor, Class P, and having automatic-reset thermal protection.

D. Ballasts for Low-Temperature Environments:
   1. Temperatures 0 Degrees F and Higher: electronic type rated for 0 degrees F starting and operating temperature with indicated lamp types.
   2. Temperature Minus 20 degrees F and Higher: Electromagnetic type designed for use with indicated lamp types.

E. Ballasts for Low Electromagnetic-Interference Environments: Comply with 47 CFR18, Ch. 1, subpart C, for imitations on electromagnetic and radio-frequency interference for consumer equipment.

2.4 BALLASTS FOR COMPACT FLUORESCENT LAMPS

A. Description: Electronic-programmed rapid-start type, complying with UL 935 and with ANSI C82.11, designed for type and quantity of lamps indicated. Ballast shall be designed for full light output unless dimmer or bi-level control is indicated:
   1. Lamp end-of-life detection and shutdown circuit.
   2. Automatic lamp starting after lamp replacement.
   3. Sound Rating: Class A.
   4. Total Harmonic Distortion Rating: Less than 20 percent.
   5. Transient Voltage Protection: IEEE C62.41.1 and IEEE C62.41.2, Category A or better.
   6. Operating Frequency: 20 kHz or higher.
   7. Lamp Current Crest Factor: 1.7 or less.
   8. BF: 0.95 or higher unless otherwise indicated.
   9. Power Factor: 0.95 or higher.

2.5 EMERGENCY FLUORESCENT POWER UNIT

A. Internal Type: Self-contained, modular, battery-inverter unit, factory mounted within lighting fixture body and compatible with ballast. Comply with UL 924.
   1. Emergency Connection: Operate one fluorescent lamp(s) continuously at an output of 1100 lumens each. Connect unswitched circuit to battery-inverter unit and switched circuit to fixture ballast.
2. Test Push Button and Indicator Light: Visible and accessible without opening fixture or entering ceiling space.
   a. Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
   b. Indicator Light: LED indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.

2.6 BALLASTS FOR HID LAMPS

A. Electronic Ballast for Metal-Halide Lamps: Include the following features unless otherwise indicated:
   1. Minimum Starting Temperature: Minus 20 degrees F for single-lamp ballasts.
   2. Rated Ambient Operating Temperature: 130 degrees F.
   3. Lamp end-of-life detection and shutdown circuit.
   4. Sound Rating: Class A
   5. Total Harmonic Distortion Rating: Less than 20 percent.
   6. Transient Voltage Protection: IEEE C62.41.1 and IEEE C62.41.2, Category A or better.
   7. Lamp Current Crest Factor: 1.5 or less.
   8. Power Factor: 0.90 or higher.

2.7 QUARTZ LAMP LIGHTING CONTROLLER

A. General Requirements for Controllers: Factory installed by lighting fixture manufacturer. Comply with UL 1598.

B. Standby (Quartz Restrike): automatically switches quartz lamp on when a HID lamp in the fixture is initially energized and during the HID lamp restrike period after brief power outages.

C. Connections: Designed for a single branch-circuit connection.

D. Switching Off: automatically switches quartz lamp off when HID lamp strikes.

E. Switching Off: Automatically switches quartz lamp off when HID lamp reaches approximately 60 percent light output.

2.8 EXIT SIGNS

A. General Requirements for Exit Signs: comply with UL 924; for sign colors, visibility, luminance and lettering size, comply with authorities having jurisdiction.

B. Internally Lighted Signs:
   1. Lamps for AC Operation: LEDs, 50,000 hours minimum rated lamp life.
   2. Self-Powered Exit Signs (Battery type): Integral automatic charger in a self-contained power pack.
      a. Battery: Sealed, maintenance-free, nickel-cadmium type.
      b. Charger: fully automatic, solid-state type with sealed transfer relay.
      c. Operation: Relay automatically energizes lamp from battery when circuit voltage drops to 80 percent of nominal voltage or below. When normal voltage is restored, relay disconnects lamps from battery, and battery is automatically recharged and floated on charger.
d. Test Push button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.

e. LED Indicator Light: Indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.

f. Integral Self-Test: Factory-installed electronic device automatically initiates code-required test of unit emergency operation at required intervals. Test failure is annunciated by an integral audible alarm and a flashing red LED.

2.9 EMERGENCY LIGHTING UNITS

A. General Requirements for Emergency Lighting Units: Self-contained units complying with UL 924.
   1. Battery: Sealed, maintenance-free, lead-acid type.
   2. Charger: fully automatic, solid-state type with sealed transfer relay.
   3. Operation: Relay automatically turns lamp on when power-supply circuit voltage drops to 80 percent of nominal voltage or below. Lamp automatically disconnects from battery when voltage approaches deep-discharge level. When normal voltage is restored, relay disconnects lamps from battery, and battery is automatically recharged and floated on charger.
   4. Test Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
   5. LED Indicator Light: Indicates normal power on. Normal glow indicated trickle charge; bright glow indicates charging at end of discharge cycle.

2.10 FLUORESCENT LAMPS

A. T8 rapid-start lamps, rated 32 W maximum, nominal length of 48 inches, 28000 initial lumens (minimum), CRI 75 (minimum), color temperature 3500 K, and average rated life 20,000 hours unless otherwise indicated.

B. Compact Fluorescent Lamps: 4-Pin, CRI 80 (minimum), color temperature 3500 K, average rated life of 10,000 hours at three hours operation per start unless otherwise indicated.
   1. 26 W: T4 double or triple tube, rated 1800 initial lumens (minimum).

2.11 HID LAMPS

A. Ceramic, Pulse-Start, Metal-Halide Lamps: Minimum CRI 80, and color temperature 4000K.

2.12 LIGHTING FIXTURE SUPPORT COMPONENTS

A. Comply with Division 26 Section “Hangers and Supports for Electrical Systems” for channel- and angle-iron supports and nonmetallic channel and angle supports.

B. Single-Stem Hangers: 1/2-inch steel tubing with swivel ball fittings and ceiling canopy. Finish same as fixture.

C. Twin-Stem Hangers: Two, 1/2-inch steel tubes with single canopy designed to mount a single fixture. Finish same as fixture.

D. Rod Hangers: 3/16-inch minimum diameter, cadmium-plated, threaded steel rod.
PART 3 - EXECUTION

3.1 INSTALLATION

A. Lighting fixtures:
   1. Set level, plumb, and square with ceilings and walls unless otherwise indicated.
   2. Install lamps in each luminaire.

B. Temporary Lighting: If it is necessary, and approved by Engineer, to use permanent luminaires for temporary lighting, install and energize the minimum number of luminaires necessary. When construction is sufficiently complete, remove the temporary luminaires, disassemble, clean thoroughly, install new lamps and reinstall.

C. Suspended Lighting Fixture Support:
   1. Pendants and Rods: Where longer than 48 inches, brace to limit swinging.
   3. Continuous Rows: Use tubing or stem for wiring at one point and tubing or rod for suspension for each unit length of fixture chassis, including one at each end.
   4. Do not use grid as support for pendant luminaires. Connect support wires or rods to building structure.

D. Connect wiring according to Division 26 Section “Low-Voltage Electrical Power Conductors and Cables.”

3.2 IDENTIFICATION

A. Install labels with panel and circuit numbers on concealed junction and outlet boxes. Comply with requirements for identification specified in Division 26 Section “Identification for Electrical Systems.”

3.3 FIELD QUALITY CONTROL

A. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify transfer from normal power to battery and retransfer to normal.

B. Prepare a written report of tests, inspections, observations and verifications indicating and interpreting results. If adjustments are made to lighting system, retest to demonstrate compliance with standards.

3.4 STARTUP SERVICE

A. Burn-in all lamps that require specific aging period to operate properly, prior to occupancy by Owner. Burn-in fluorescent and compact fluorescent lamps intended to be dimmed, for at least 100 hours at full voltage.

3.5 ADJUSTING

A. Adjust aimable luminaires in the presence of Owner and Engineer.

END OF SECTION
SECTION 26 56 00 - EXTERIOR LIGHTING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Exterior luminaires with lamps and ballasts.
   2. Luminaire-mounted photoelectric relays.
   3. Poles and accessories.

B. Related Sections:
   1. Division 26 Section “Interior Lighting” for exterior luminaires normally mounted on exterior surfaces of buildings.

1.2 DEFINITIONS

A. CCT: Correlated color temperature.

B. CRI: Color-rendering index.

C. HID: High-intensity discharge.

D. LER: Luminaire efficacy rating.

E. Luminaire: Complete lighting fixture, including ballast housing if provided.

F. Pole: Luminaire support structure, including tower used for larger area illumination.

G. Standard: Same definition as “Pole” above.

1.3 SUBMITTALS

A. Product Data: For each luminaire, pole, and support component, arranged in order of lighting unit designation. Include data on features, accessories, finishes and the following:
   1. Physical description of luminaire, including materials, dimensions, effective projected area, and verification of indicated parameters.
   2. Details of attaching luminaires and accessories.
   3. Details of installation and construction.
   4. Luminaire materials.
   5. Photometric data based on laboratory tests of each luminaire type, complete with indicated lamps, ballasts and accessories.
      a. Manufacturer Certified Data: Photometric data shall be certified by manufacturer’s laboratory with a current accreditation under the National Voluntary Laboratory Accreditation Program for Energy Efficient Lighting Products.
   6. Photoelectric relays.
   7. Ballasts, including energy-efficiency data.
   8. Lamps, including life, output, CCT, CRI, lumens and energy-efficiency data.
   9. Materials, dimensions and finishes of poles.
   10. Means of attaching luminaires to supports, and indication that attachment is suitable for components involved.
   11. Anchor bolts for poles.

B. Shop Drawings: Include plans, elevations sections, details and attachments to other work.
1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components and location and size of each field connection.
2. Anchor-bolt templates keyed to specific poles and certified by manufacturer.
3. Wiring Diagrams: for power, signal, and control wiring.

C. Qualification Data: for qualified agencies providing photometric data for lighting fixtures.
D. Field quality-control reports.
E. Operation and Maintenance Data: For luminaires and poles to include in emergency, operation and maintenance manuals.
F. Warranty: Sample of special warranty.

1.4 QUALITY ASSURANCE

A. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by an independent agency, with the experience and capability to conduct the testing indicated, that is an NRTL as defined by OSHA in 29 CFR 1910.
B. Electrical Components, Devices and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency and marked for intended location and application.
D. Comply with NFPA 70.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Package aluminum poles for shipping according to ASTM B 660.
B. Store poles on decay-resistant-treated skids at least 12 inches above grade and vegetation. Support poles to prevent distortion and arrange to provide free air circulation.
C. Retain factory-applied pole wrappings on metal poles until right before pole installation. For poles with nonmetallic finishes, handle with web fabric straps.

1.6 WARRANTY

A. Special Warranty: Manufacturer’s standard form in which manufacturer agrees to repair or replace products that fail in materials or workmanship; that corrode; or that fade, stain, perforate, erode or chalk due to effects of weather or solar radiation within specified warranty period. Manufacturer may exclude lightning damage, hail damage, vandalism, abuse, or unauthorized repairs or alterations from special warranty coverage.
   1. Warranty Period for Luminaires: Five years from date of Substantial Completion.
   2. Warranty Period for Poles: Repair or replace lighting poles and standards that fail in finish, materials, and workmanship within manufacturer’s standard warranty period, but not less than three years from date of Substantial Completion.

1.7 EXTRA MATERIALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
1. Lamps: One for every 10 of each type and rating installed. Furnish at least one of each type.
2. Glass and Plastic Lenses, Covers and Other Optical Parts: One for every 100 of each type and rating installed. Furnish at least one of each type.
3. Ballasts: One for every 10 of each type and rating installed. Furnish at least one of each type.
4. Gloves and Guards: One for every 20 of each type and rating installed. Furnish at least one of each type.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Products: Subject to compliance with requirements, available products that may be incorporated into the work include, but are not limited to, product(s) indicated on Drawings.

B. Substitutions:
   1. Provide complete literature for each luminaire substitution:
   2. Submittals for substituted luminaires shall be sufficient for competent comparison of the proposed luminaire to the originally specified luminaire:
      a. Photometric data:
         1) IES file in standard IES format.
         2) Coefficient of utilization tables based on the IES zonal cavity system by an approved testing laboratory.
         3) Candlepower distribution curves.
         4) Average luminaire brightness.
         5) Lumen output charts.
         6) Power requirements in watts and volt-amperes.
      b. Calculations:
         1) Provide software generated calculations showing illuminance levels in footcandles and power usage in watts per square foot for each of the areas in which substitutions are proposed:
            a) Use surface reflectance values and luminaire light loss factors approved by the Engineer to perform all calculations.
   3. Substitutions for specified luminaires will be evaluated upon quality of construction, light distribution, energy use, appearance, and maintenance.
   4. Substitutions shall comply with all applicable building codes.

2.2 GENERAL REQUIREMENTS FOR LUMINAIRE

A. Luminaires shall comply with UL 1598 and be listed and labeled for installation in wet locations by an NRTL acceptable to authorities having jurisdiction.

B. Lateral Light Distribution Patterns: Comply with IESNA RP-8 for parameters of lateral light distribution patterns indicated for luminaires.

C. Metal Parts: Free of burrs and sharp corners and edges.

D. Sheet Metal Components: corrosion-resistant aluminum unless otherwise indicated. Form and support to prevent warping and sagging.

E. Housings: Rigidly formed, weather- and light-tight enclosures that will not warp, sag or deform in use. Provide filter/breather for enclosed luminaires.
F. Doors, Frames, and other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position. Doors shall be removable for cleaning or replacing lenses. Designed to disconnect ballast when door opens.

G. Exposed Hardware Material: Stainless steel.

H. Plastic Parts: High resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.

I. Reflecting surfaces shall have minimum reflectance as follows unless otherwise indicated:
1. White Surfaces: 85 percent.
2. Specular Surfaces: 83 percent
3. Diffusing specular Surfaces: 75 percent.

J. Lenses and Refractors Gaskets: Use heat- and aging-resistant resilient gaskets to seal and cushion lenses and refractors in luminaire doors.

K. Luminaire Finish: Manufacturer's standard paint applied to factory-assembled and test luminaire before shipping. Where indicated, match finish process and color of pole or support materials.

L. Factory-Applied Finish for Steel Luminaires: Comply with NAAMM's “Metal Finishes Manual for Architectural and Metal Products” for recommendations for applying and designating finishes.
1. Surface Preparation: Clean surfaces to comply with SSPC-SP 1, “Solvent Cleaning,” to remove dirt, oil, grease, and other contaminants that could impair paint bond. Grind welds and polish surfaces to a smooth, even finish. Remove mill scale and rust, if present, from uncoated steel, complying with SSPC-SP 5/NACE No. 1, “White Metal Blast Cleaning,” or SSPC-SP 8, “Pickling.”
2. Exterior Surfaces: Manufacturer's standard finish consisting of one or more coats of primer and two finish coats of high-gloss, high-build polyurethane enamel.
   a. Color: As selected by Engineer from manufacturer’s full range.

M. Factory-Applied Finish for aluminum Luminaires: comply with NAAMM’s “Metal finishes Manual for Architectural and Metal Products” for recommendations for applying and designating finishes.
1. Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.
2. Class 1, Color Anodic Finish: AA-M32C22A42/A44 (Mechanical Finish: medium satin; Chemical Finish: etched, medium matte; Anodic Coating: Engineerural Class I, integrally colored or electrolytically deposited color coating 0.018 mm or thicker) complying with AAMA 611.

N. Factory-Applied Labels: Comply with UL 1598. Include recommended lamps and ballasts. Labels shall be located where they will be readily visible to service personnel, but not seen from normal viewing angles when lamps are in place.
1. Label shall include the following lamp and ballast characteristics:
   a. “USES ONLY” and include specific lamp type.
   b. Lamp diameter code (T-4, T-5, T-8, T-12), tube configuration (twin, quad, triple), base type, and nominal wattage for fluorescent and compact fluorescent luminaires.
   c. Lamp type, wattage, bulb type (ED17, BD56, etc.) and coating (clear or coated) for HID luminaires.
   d. Start type (preheat, rapid start, instant start) for fluorescent and compact fluorescent luminaires.
   e. ANSI ballast type (M98, M57, etc.) for HID luminaires.
f. CCT and CRI for all luminaires.

2.3 Luminaire-Mounted Photoelectric Relays

A. Comply with UL 773 or UL 773A.

B. Contact Relays: Factory mounted, single throw, designed to fail in the on position, and factory set to turn light unit on at 1.5 to 3 fc and off at 4.5 to 10 fc with 15-second minimum time delay. Relay shall have directional lens in front of photocell to prevent artificial light sources from causing false turnoff.
   1. Relay with locking-type receptacle shall comply with ANSI C136.10.
   2. Adjustable window slide for adjusting on-off set points.

2.4 Ballasts for HID Lamps

A. Comply with ANSI C82.4 and UL 1029 and capable of open-circuit operation without reduction of average lamp life. Include the following features unless otherwise indicated:
   1. Ballast Circuit: Constant-wattage autotransformer or regulating high-power-factor type.
   2. Minimum Starting Temperature: Minus 22 deg. F.
   3. Normal Ambient Operating Temperature: 104 deg F.
   4. Ballast Fuses: One in each ungrounded power supply conductor. Voltage and current ratings as recommended by ballast manufacturer.

2.5 HID Lamps

A. Metal-Halide Lamps: ANSI C78.43, with minimum CRI 65 Insert value, and CCT color temperature 4000 K.

2.6 General Requirements for Poles and Support Components

A. Structural Characteristics: Comply with AASHTO LTS-4-M.
   1. Wind-Load Strength of Poles: Adequate at indicated heights above grade without failure, permanent deflection, or whipping in steady winds of speed.
   2. Strength Analysis: for each pole, multiply the actual equivalent projected area of luminaires and brackets by a factor of 1.1 to obtain the equivalent projected area to be used in pole selection strength analysis.

B. Luminaire Attachment Provisions: Comply with luminaire manufacturers’ mounting requirements. Use stainless-steel fasteners and mounting bolts unless otherwise indicated.

C. Mountings, Fasteners and Appurtenances: Corrosion-resistant items compatible with support components.
   1. Materials: shall not cause galvanic action at contact points.
   2. Anchor Bolts, Leveling Nuts, Bolt Caps, and washers: Stainless steel unless otherwise indicated.
   3. Anchor-bolt Template: Plywood or steel.

D. Handhole: Oval-shaped, with minimum clear opening of 2-1/2 by 5 inches, with cover secured by stainless-steel captive screws. Provide on all poles.

E. Concrete Pole Foundations: Cast in place, with anchor bolts to match pole-base flange.
2.7 ALUMINUM POLES

A. Poles: Seamless, extruded structural tube complying with STM B429/B 429M, alloy 6063-T6 with access handhole in pole wall.

B. Poles: ASTM B209, 5052-H34 marine sheet alloy with access handhole in pole wall.
   1. Shape: Round, tapered Round, straight Square, tapered Square, straight.
   2. Mounting Provisions: Butt flange for bolted mounting on foundation or breakaway support.

C. Pole-Top Tenons: Fabricated to support luminaire or luminaires and brackets indicated, and securely fastened to pole top.

D. Grounding and Bonding Lugs: Welded ½-inch threaded lug, complying with requirements in Division 26 Section “Grounding and Bonding for Electrical Systems,” listed for attaching grounding and bonding conductors of type and size listed in that Section, and accessible through handhole.

E. Brackets for Luminaires: Detachable, with pole and adapter fittings of cast aluminum. Adapter fitting welded to pole and bracket, then bolted together with stainless-steel bolts.
   1. Tapered oval cross section, with straight tubular end section to accommodate luminaire.
   2. Finish: Same as pole and luminaire.

F. Aluminum Finish: Comply with NAAMM’s “Metal Finishes Manual for Architectural and Metal Products” for recommendations for applying and designating finishes.
   1. Finish designations prefixed by AA comply with the system established by the aluminum Association for designating aluminum finishes.
   2. Class 1, Color Anodic Finish: AA-M32C22A42/A44 (Mechanical Finish: medium satin; Chemical Finish: etched, medium matte; Anodic Coating: Engineerural Class I, integrally colored or electrolytically deposited color coating 0.018 mm or thicker) complying with AAMA 611.
      a. Color: As selected by Engineer from manufacturer’s full range.

2.8 POLE ACCESSORIES

A. Base Covers: Manufacturers’ standard metal units, arranged to cover pole’s mounting bolts and nuts. Finish same as pole.

PART 3 - EXECUTION

3.1 LUMINAIRE INSTALLATION

A. Install lamps in each luminaire.

B. Fasten luminaire to indicated structural supports.

C. Adjust luminaires that require field adjustment or aiming. Include adjustment of photoelectric device to prevent false operation of relay by artificial light sources, favoring a north orientation.

3.2 POLE INSTALLATION

A. Alignment: Align pole foundations and poles for optimum directional alignment of luminaires and their mounting provisions on the pole.
B. Clearances: Maintain the following minimum horizontal distances of poles from surface and underground features unless otherwise indicated on Drawings:
   1. Fire Hydrants and Storm Drainage Piping: 60 inches.
   3. Trees: 15 feet from tree trunk.

C. Concrete Pole Foundations: Set anchor bolts according to anchor-bolt templates furnished by pole manufacturer.

D. Foundation-Mounted Poles: Mount pole with leveling nuts and tighten top nuts to torque level recommended by pole manufacturer.
   1. Grout void between pole base and foundation. Use nonshrink or expanding concrete grout firmly packed to fill space.
   2. Install base covers unless otherwise indicated.
   3. Use a short piece of ½ inch diameter pipe to make a drain hole through grout. Arrange to drain condensation from interior of pole.

E. Raise and set poles using web fabric slings (not chain or cable).

3.3 CORROSION PREVENTION

A. Aluminum: Do not use in contact with earth or concrete. When in direct contact with a dissimilar metal, protect aluminum by insulating fittings or treatment.

B. Steel Conduits: Comply with Division 26 Section “Raceway and Boxes for Electrical Systems.” In concrete foundations, wrap conduit with 0.010-inch-thick, pipe-wrapping plastic tape applied with a 50 percent overlap.

3.4 GROUNDING

A. Ground metal poles and support structures according to Division 26 Section “Grounding and Bonding for Electrical Systems.”
   1. Install grounding electrode for each pole unless otherwise indicated.
   2. Install grounding conductor pigtail in the base for connecting luminaire to grounding system.

B. Ground nonmetallic poles and support structures according to Division 26 Section “Grounding and Bonding for Electrical Systems.”
   1. Install grounding electrode for each pole.
   2. Install grounding conductor and conductor protector.
   3. Ground metallic components of pole accessories and foundations.

3.5 FIELD QUALITY CONTROL

A. Inspect each installed fixture for damage. Replace damaged fixtures and components.

B. Illumination Observations: Verify normal operation of lighting units after installing luminaires and energizing circuits with normal power source.
   1. Verify operation of photoelectric controls.

C. Prepare a written report of tests, inspections, observations, and verifications indicating and interpreting results. If adjustments are made to lighting system, retest to demonstrate compliance with standards.
3.6 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate and maintain luminaire lowering devices.

END OF SECTION
DIVISION 31

EARTHWORK
PART 1 - GENERAL

1.1 SCOPE
A. This work shall consist of the installation of a non-woven geotextile fabric below the riprap.

1.2 RELATED SECTIONS
A. Section 31 37 00, RIPRAP

1.3 REFERENCE STANDARDS
B. ASTM D4355 – Standard Test Method for Deterioration of Geotextiles by Exposure to Light, Moisture and Heat in a Xenon Arc Type Apparatus
C. ASTM D4491 – Standard Test Methods for Water Permeability of Geotextiles by Permittivity
I. ASTM D6241 – Standard Test Method for Static Puncture Strength of Geotextiles and Related Products Using a 50mm Probe

1.4 QUALITY ASSURANCE
A. The installation shall be performed in accordance with the manufacturer's recommendations and as directed by Engineer.

1.5 SUBMITTALS
A. See Section 01 33 00, SUBMITTAL PROCEDURES.
B. Certificates: Certify that products meet or exceed specified requirements.

PART 2 - PRODUCTS

2.1 MATERIAL
A. The non-woven geotextile fabric shall be an 8-ounce fabric, US Fabrics US 205NW or equal. The fabric shall be of non-woven needle punched construction and consist of long-chain polymeric filaments or fibers composed of polypropylene, polyethylene or polyamide. The
filaments and fibers shall be oriented whereby they retain their relative positions with each other and allow the passage of water as specified.

B. The fabric shall be mildew, insect and rodent resistant and shall be inert to chemicals commonly found in soil. The non-woven fabric shall conform to the physical property requirements below:

<table>
<thead>
<tr>
<th>Physical Property</th>
<th>Value</th>
<th>Test Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weight</td>
<td>8 oz/sy</td>
<td>ASTM D 5261</td>
</tr>
<tr>
<td>Tensile Strength, wet</td>
<td>205 lbs</td>
<td>ASTM D 4632</td>
</tr>
<tr>
<td>Elongation, wet</td>
<td>50%</td>
<td>ASTM D 4632</td>
</tr>
<tr>
<td>Permittivity</td>
<td>1.35 sec⁻¹</td>
<td>ASTM D 4491</td>
</tr>
<tr>
<td>Puncture Strength</td>
<td>130 lbs</td>
<td>ASTM D 4833</td>
</tr>
<tr>
<td>CBR Puncture</td>
<td>535 lbs</td>
<td>ASTM D 6241</td>
</tr>
<tr>
<td>Mullen Burst Strength</td>
<td>350 psi</td>
<td>ASTM D 3786</td>
</tr>
<tr>
<td>Abrasion Resistance, % Strength Retained</td>
<td>90</td>
<td>ASTM D 4886</td>
</tr>
<tr>
<td>Apparent Opening Size (AOS)</td>
<td>80 US Sieve</td>
<td>ASTM D 4751</td>
</tr>
<tr>
<td>Ultraviolet Resistance, % Strength Retention</td>
<td>70%</td>
<td>ASTM D 4355 (after 500 Xenon Weatherometer hrs.)</td>
</tr>
<tr>
<td>Trapezoidal Tear</td>
<td>85 lbs</td>
<td>ASTM D 4533</td>
</tr>
<tr>
<td>Water Flow Rate</td>
<td>90 gpm/sf</td>
<td>ASTM D 4491</td>
</tr>
</tbody>
</table>

C. The non-woven geotextile fabric shall be furnished in a protective wrapping which shall protect the fabric from ultraviolet radiation and from abrasion due to shipping and handling.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Fabric Exposure Following Placement - Exposure of the geotextile filter fabric to the elements, particularly the sun, between lay down and cover shall be a maximum of 7 days.

B. The non-woven geotextile fabric shall be placed in the manner and at the locations shown on the drawings or as directed by the Engineer. The surface to receive the fabric shall be prepared to a smooth condition free of obstructions, depressions and debris. The fabric shall be placed loosely, not in a stretched condition.

C. The Contractor shall anchor the geotextile fabric at outer edges of the riprap courses by embedding the fabric down, across, and up a 1-foot deep by 1-feet wide trench. The fabric shall be centered on the pipe. The anchoring trench shall be backfilled with rock material approved by Engineer. There will be no separate payment for Geotextile Fabric; it shall be subsidiary to other items.

D. Where necessary, the fabric shall be placed so as to provide a minimum 24-inch overlap. The fabric shall be placed transverse to the direction of the flow with the upstream panel overlapping the downstream panel. All installations shall be subject to approval by Engineer.

E. Repairs - A geotextile patch, of the same material, shall be placed over any damaged area and shall extend 12-inches beyond the perimeter of the tear or damaged area. Patch shall be either glued or sewn to the mother fabric or as approved by Engineer.
SECTION 31 11 00 - SITE PREPARATION

PART 1 - GENERAL

1.1 DEFINITIONS

A. Interfering or Objectionable Material: Trash, rubbish, and junk; vegetation and other organic matter, whether alive, dead, or decaying; topsoil.

B. Clearing: Removal of interfering or objectionable material lying on or protruding above ground surface.

C. Grubbing: Removal of vegetation and other organic matter including stumps, buried logs, and roots greater than 2 inches caliper to a depth of 12 inches below subgrade.

D. Scalping: Removal of sod without removing more than upper 3 inches of topsoil.

E. Stripping: Removal of topsoil remaining after applicable scalping is completed.

F. Project Limits: Areas, as shown or specified, within which Work is to be performed.

1.2 SUBMITTALS

A. Shop Drawings: Drawings clearly showing clearing, grubbing, and stripping limits.

1.3 QUALITY ASSURANCE

A. Obtain Engineer’s approval of staked clearing, grubbing, and stripping limits, prior to commencing clearing, grubbing, and stripping.

1.4 SCHEDULING AND SEQUENCING

A. Prepare site only after adequate erosion and sediment controls are in place. Limit areas exposed uncontrolled to erosion during installation of temporary erosion and sediment controls to maximum of 5 acres.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 GENERAL

A. Clear, grub, and strip areas actually needed for waste disposal, borrow, or site improvements within limits shown or specified.

B. Do not injure or deface vegetation that is not designated for removal.

3.2 LIMITS

A. As follows, but not to extend beyond Project limits.

1. Excavation, including trenches, 5 feet beyond top of cut slopes or shored walls.

2. Fill:
   a. Clearing and Grubbing: 5 feet beyond toe of permanent fill.
   b. Stripping and Scalping: 2 feet beyond toe of permanent fill.

4. Roadways: Clearing, grubbing, scalping, and stripping 15 feet from centerline.
5. Other Areas: As shown.

B. Remove rubbish, trash, and junk from entire area within Project limits.

3.3 CLEARING
A. Clear areas within limits shown or specified.
B. Fell trees so that they fall away from facilities and vegetation not designated for removal.
C. Cut stumps not designated for grubbing to within 6 inches of ground surface.
D. Cut off shrubs, brush, weeds, and grasses to within 2 inches of ground surface.

3.4 GRUBBING
A. Grub areas within limits shown or specified.

3.5 SCALPING
A. Do not remove sod until after clearing and grubbing is completed and resulting debris is removed.
B. Scalp areas within limits shown or specified.

3.6 STRIPPING
A. Do not remove topsoil until after scalping is completed.
B. Strip areas within limits to minimum depths shown or specified. Do not remove subsoil with topsoil.
C. Stockpile strippings, meeting requirements for topsoil, separately from other excavated material.

3.7 TOPSOIL
A. Natural, friable, sandy loam, obtained from well-drained areas, free from objects larger than 1-1/2 inches maximum dimension, and free of subsoil, roots, grass, other foreign matter, hazardous or toxic substances, and deleterious material that may be harmful to plant growth or may hinder grading, planting, or maintenance.

3.8 DISPOSAL
A. Clearing and Grubbing Debris:
   1. Dispose of debris
   2. Burning of debris will not be allowed.
   3. Woody debris may be chipped. Chips may be sold to Contractor's benefit or used for landscaping as mulch or uniformly mixed with topsoil, provided that resulting mix will be fertile and not support combustion. Maximum dimensions of chipped material used shall be 1/4-inch by 2 inch. Dispose of chips that are unsaleable or unsuitable for landscaping or other uses with unchipped debris.
   4. Limit disposal of clearing and grubbing debris to locations that are approved by federal, state, and local authorities, and that will not be visible from Project.
B. Scalpings: As specified for clearing and grubbing debris.

C. Strippings:
   1. Dispose of strippings that are unsuitable for topsoil or that exceed quantity required for topsoil
   2. Stockpile topsoil in sufficient quantity to meet Project needs. Dispose of excess strippings as specified for clearing and grubbing.

END OF SECTION
SECTION 31 22 13 - SUBGRADE PREPARATION

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes: Work and testing required for preparing subgrade.

B. Related sections:
   1. Section 31 11 00 – Site Preparation.
   2. Section 31 23 16 – Excavation.
   3. Section 31 23 23.13 – Fill and Backfill.

1.2 REFERENCE STANDARDS

A. ASTM D1557 – Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft³)

B. ASTM D698 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft³)

1.3 DEFINITIONS

A. Optimum Moisture Content: As defined in Section 31 23 23.13, FILL AND BACKFILL.

B. Prepared Ground Surface: Ground surface after completion of clearing and grubbing, scalping of sod, stripping of topsoil, excavation to grade, and scarification and compaction of subgrade.

C. Relative Compaction: As defined in Section 31 23 23.13, FILL AND BACKFILL.

D. Relative Density: As defined in Section 31 23 23.13, FILL AND BACKFILL.

E. Subgrade: Layer of existing soil after completion of clearing, grubbing, scalping of topsoil prior to placement of fill, roadway structure or base for floor slab.


1.4 SEQUENCING AND SCHEDULING

A. Complete applicable Work specified in Sections 31 11 00, SITE PREPARATION; and 31 23 16, EXCAVATION, prior to preparation.

1.5 QUALITY ASSURANCE

A. Notify Engineer when subgrade is ready for compaction or whenever compaction is resumed after a period of extended inactivity.

1.6 ENVIRONMENTAL REQUIREMENTS

A. Prepare subgrade when unfrozen and free of ice and snow.
PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 GENERAL

A. Keep subgrade free of water, debris, and foreign matter during compaction or proof-rolling.

B. Bring subgrade to proper grade and cross-section and uniformly compact surface.

C. Do not use sections of prepared ground surface as haul roads. Protect prepared from traffic.

D. Maintain prepared ground surface in finished condition until next course is placed.

3.2 MOISTURE CONDITIONING

A. Dry Subgrade: Add water, then mix to make moisture content uniform throughout.

B. Wet Subgrade: Aerate material by blading, discing, harrowing, or other methods, to hasten drying process.

3.3 TESTING

A. Test roll subgrade as specified in Standard Specifications to detect soft or loose subgrade or unsuitable material, as determined by Engineer.

3.4 CORRECTION

A. Soft or Loose Subgrade:
1. Adjust moisture content and recompact, or
2. Over excavate as specified in Section 31 23 16, EXCAVATION, and replace with suitable material from the excavation, as specified in Section 31 23 23.13, FILL AND BACKFILL

END OF SECTION
SECTION 31 22 19 - GRADING

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes:
   1. Removal and storage of topsoil.
   2. Rough grading the site for site structures, building pads, and drive and parking isles.
   3. Finish grading for planting.

B. Related sections:
   1. Section 31 23 16 – Excavation.
   2. Section 31 23 23.13 – Fill and Backfill.

1.2 SUBMITTALS

A. Project Record Documents: Accurately record actual locations of utilities remaining by horizontal dimensions, elevations or inverts, and slope gradients.

1.3 QUALITY ASSURANCE

A. Perform Work in accordance with State of Alabama Highway Department standards.
   1. Maintain one copy on site.

1.4 PROJECT CONDITIONS

A. Protect above – and below – grade utilities that remain.

B. Protect plants, lawns, rock outcroppings, and other features to remain as a portion of final landscaping.

C. Protect bench marks, survey control points, existing structures, fences, sidewalks, paving and curbs from grading equipment and vehicular traffic.

PART 2 - PRODUCTS

2.1 MATERIALS.

A. Topsoil: Shall be soil suitable for sustaining grass and vegetation and shall not have any particles larger than 3/4 inch diameter and shall be free of any trash, debris, or deleterious material.

B. Other Fill Materials: See Section 31 23 23.13, FILL AND BACKFILL.

PART 3 - EXECUTIONS

3.1 EXAMINATION

A. Verify that survey bench mark and intended elevations for the Work are as indicated.

3.2 PREPARATION

A. Identify required lines, levels, contours, and datum.
B. Stake and flag locations of known utilities.
C. Locate, identify, and protect utilities that remain from damage.
D. Notify utility company to remove and relocate utilities.

3.3 ROUGH GRADING

A. Remove topsoil from areas to be further excavated, re-landscaped, or re-graded without mixing with foreign materials.
B. Do not remove topsoil when wet.
C. Remove subsoil from areas to be further excavated, re-landscaped, or re-graded.
D. Do not remove wet subsoil, unless it is subsequently processed to obtain optimum moisture content.
E. When excavating through roots, perform work by hand and cut roots with sharp axe.
F. Stability: Replace damaged or displaced subsoil to same requirements as for specified fill.

3.4 SOIL REMOVAL

A. Stockpile excavated topsoil on site.
B. Stockpile excavated subsoil on site.
C. Stockpiles: Use areas designated on site; pile depth not to exceed 8 feet; protect from erosion.

3.5 FINISH GRADING

A. Before Finish Grading:
   1. Verify building and trench backfilling have been inspected.
   2. Verify subgrade has been contoured and compacted.
B. Remove debris, roots, branches, stones, in excess of ½ inch in size. Remove soil contaminated with petroleum products.
C. In areas where vehicles or equipment have compacted soil, scarify surface to depth of 3 inches.
D. Place topsoil in areas where seeding are indicated.
E. Place topsoil to the following compacted thicknesses:
   1. Areas to be Seeded with Grass: 6 inches.
   2. Areas to be Sodded: 4 inches.
   4. Flower Beds: 12 inches
   5. Planter Boxes: To within 3 inches of box rim.
F. Place topsoil during dry weather.
G. Remove roots, weeds, rocks, and foreign material while spreading.
H. Near plants spread topsoil manually to prevent damage.
I. Fine grade topsoil to eliminate uneven areas and low spots. Maintain profiles and contour of subgrade.

J. Lightly compact placed topsoil.

3.6 TOLERANCES

A. Top Surface of Subgrade: Plus or minus 1/10 foot from required elevation.

B. Top Surface of Finish Grade: Plus or minus 1/2 inch.

3.7 FIELD QUALITY CONTROL

A. See Section 31 23 23.13, FILL AND BACKFILL for compaction density testing.

3.8 CLEANING AND PROTECTION

A. Remove unused stockpiled topsoil and subsoil. Grade stockpile area to prevent standing water.

B. Leave site clean and raked, ready to receive landscaping.

END OF SECTION
SECTION 31 23 16 - EXCAVATION

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes: Work and materials associated with excavation.

B. Related sections:
   1. Section 01 50 00 – Temporary Facilities and Controls.
   2. Section 31 11 00 – Site Preparation.
   4. Section 31 50 00 – Excavation Support Systems.

1.2 SUBMITTALS

A. Shop Drawings:
   1. Excavation Plan, Detailing:
      a. Methods and sequencing of excavation.
      b. Proposed locations of stockpiled excavated material.
      c. Proposed and spoil disposal sites.
      d. Numbers, types, and sizes of equipment proposed to perform excavations.

1.3 QUALITY ASSURANCE

A. Provide adequate survey control to avoid unauthorized overexcavation.

1.4 WEATHER LIMITATIONS

A. Material excavated when frozen or when air temperature is less than 32 degrees F shall not be used as fill or backfill until material completely thaws.

B. Material excavated during inclement weather shall not be used as fill or backfill until after material drains and dries sufficiently for proper compaction.

1.5 SEQUENCING AND SCHEDULING

A. Clearing, Grubbing, and Stripping: Complete applicable Work specified in Section 31 11 00, SITE PREPARATION, prior to excavating.

B. Dewatering: Conform to applicable requirements of Section 31 23 19, DEWATERING, prior to initiating excavation.

C. Excavation Support: Install and maintain, as specified in Section 31 50 00, EXCAVATION SUPPORT SYSTEMS, as necessary to support sides of excavations and prevent detrimental settlement and lateral movement of existing facilities, adjacent property, and completed Work.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 GENERAL

A. Excavate to lines, grades, and dimensions shown and as necessary to accomplish Work. Excavate to within tolerance of plus or minus 0.1-foot except where dimensions or grades are
shown or specified as maximum or minimum. Allow for forms, working space, granular base, topsoil, and similar items, wherever applicable. Trim to neat lines where concrete is to be deposited against earth.

B. Do not overexcavate without written authorization of Engineer.

C. Remove or protect obstructions as shown and as specified in Section 01 50 00, TEMPORARY FACILITIES AND CONTROLS.

3.2 UNCLASSIFIED EXCAVATION

A. Excavation is unclassified. Complete all excavation regardless of the type, nature, or condition of the materials encountered.

3.3 TRENCH WIDTH

A. Minimum Width of Trenches:
   1. Single Pipes, Conduits, Direct-Buried Cables, and Duct Banks:
      a. Less than 4-inch Outside Diameter or Width: 18 inches.
      b. Greater than 4-inch and up to 18-inch Outside Diameter or Width: 12 inches greater than outside diameter or width of pipe, conduit, direct-buried cable, or duct bank.
      c. Greater than 18-inch Diameter or Width: 24-inches greater than outside diameter or width of pipe, conduit, direct-buried cable, or duct bank.
   2. Multiple Pipes, Conduits, Cables, or Duct Banks in Single Trench: 18 inches greater than aggregate width of pipes, conduits, cables, duct banks, plus space between.
   3. Increase trench widths by thicknesses of sheeting.

B. Maximum Trench Width: Unlimited, unless otherwise shown or specified, or unless excess width will cause damage to existing facilities, adjacent property, or completed Work.

3.4 PIPE BEDDING GROOVES FOR NONPERFORATED DRAIN LINES

A. Semicircular, trapezoidal, or 90-degree-V.

B. Excavated or plowed into trench bottom. Forming groove by compaction will not be acceptable.

3.5 STOCKPILING EXCAVATED MATERIAL

A. Stockpile excavated material that is suitable for use as fill or backfill until material is needed.

B. Post signs indicating proposed use of material stockpiled. Post signs that are readable from all directions of approach to each stockpile. Signs should be clearly worded and readable by equipment operators from their normal seated position.

C. Confine stockpiles to within easements, rights-of-way, and approved work areas. Do not obstruct roads or streets.

D. Do not stockpile excavated material adjacent to trenches and other excavations unless excavation side slopes and excavation support systems are designed, constructed, and maintained for stockpile loads.

E. Do not stockpile excavated materials near or over existing facilities, adjacent property, or completed Work, if weight of stockpiled material could induce excessive settlement.
3.6 DISPOSAL OF SPOIL

A. Dispose of excavated materials, which are unsuitable or exceed quantity needed for fill or backfill,

B. Dispose of debris resulting from removal of organic matter, trash, refuse, and junk as specified in Section 31 11 00, SITE PREPARATION, for clearing and grubbing debris.

3.7 EXCAVATION SAFETY

A. Conform to all applicable federal, state, and local regulations.

3.8 SUBGRADE PREPARATION

A. The excavation for all structures and facilities shall be in dewatered, firm, undisturbed earth. If, in the Engineer’s opinion, the has been disturbed, corrective measures may include:
   1. Scarification and recompaction to 95 percent relative compaction or,
   2. Overexcavation and replacement with compacted granular fill.

B. If the source of disturbance is determined to be the result of the actions, or inactions of the Contractor, (for example, inadequate dewatering, disturbance by excavating or hauling equipment) the cost of additional subgrade preparation will be at the Contractor’s expense.

END OF SECTION
SECTION 31 23 16.13 - TRENCHING FOR SITE UTILITIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes
   1. Backfilling and compacting for utilities outside the building to utility main connections.

B. Related Sections
   1. Section 31 22 19, GRADING.
   2. Section 31 23 16, EXCAVATION.
   3. Section 31 23 23.13, FILL AND BACKFILL.
   4. Section 31 23 23.16, TRENCH BACKFILL.

C. DEFINITIONS
   1. Subgrade Elevations: 4 inches below finish grade elevations indicated on drawings, unless otherwise indicated.
   2. Finish Grade Elevations: 4 inches above subgrade elevations indicated on drawings, unless otherwise indicated.

D. SUBMITTALS
   1. See Section 01 33 00, SUBMITTAL PROCEDURES, for submittal procedures.
   2. Compaction Density Test Reports.

E. PROJECT CONDITIONS
   1. Provide sufficient quantities of fill to meet project schedule and requirements. When necessary, store materials on site in advance of need.
   2. Verify that survey bench marks and intended elevations for the work are as indicated.

PART 2 - PRODUCTS

2.1 FILL MATERIALS

A. As specified in Section 31 23 23.16, TRENCH BACKFILL.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Identify required lines, levels, contours, and datum locations.

B. Locate, identify, and protect utilities that remain and protect from damage.

C. Notify utility company to remove and relocate utilities.

D. See Section 31 22 19, GRADING, for additional requirements.

3.2 TRENCHING

A. Notify Owner’s Representative of unexpected subsurface conditions and discontinue affected work in areas until notified to resume work.

B. Slope banks of excavations deeper than 4 feet to angle of repose or less until shored.
C. Do not interfere with 45 degree bearing splay of foundations.
D. Cut trenches wide enough to allow inspection of installed utilities.
E. Hand trim excavations. Remove loose matter.
F. Remove excavated material that is unsuitable for re-use from site.
G. Remove excess excavated material from site.

3.3 PREPARATION FOR UTILITY PLACEMENT
A. Cut out soft areas of subgrade not capable of compaction in place. Backfill with general fill.
B. Compact subgrade to density equal to or greater than requirements for subsequent fill material.
C. Until ready to backfill, maintain excavations and prevent loose soil from falling into excavation.

3.4 BACKFILLING
A. Backfill to contours and elevations indicated using unfrozen materials.
B. Employ a placement method that does not disturb or damage other work.
C. Systematically fill to allow maximum lime for natural settlement. Do not fill over porous, wet, frozen or spongy subgrade surfaces.
D. Maintain optimum moisture content of fill materials to attain required compaction density.
E. Store grade away from building minimum 2 inches in 10 ft. unless noted otherwise. Make gradual grade changes. Blend slope into level areas.
F. Correct areas that are over-excavated.
   1. Thrust bearing surfaces: Fill with concrete.
   2. Other areas: Use general fill, flush to required elevation, compacted to minimum 97 percent of maximum dry density.

G. Compaction Density Unless Otherwise Specified or Indicated.
   1. Under paving, slabs-on-grade, and similar construction: 97 percent of maximum dry density.
   2. All other locations: 95 percent of maximum dry density.
H. Reshape and re-compact fills subjected to vehicular traffic.

3.5 BEDDING AND FILL AT SPECIFIC LOCATIONS
A. Utility Piping, Conduits, and Duct Bank:
   2. Cover with general fill.
   3. Fill up to subgrade elevation.
   4. Compact in maximum 8 inch lifts to 95 percent of maximum dry density.

B. At Pipe Culverts:
   1. Bedding: use general fill.
2. Place filter fabric specified in Section 31 05 19.13, GEOTEXTILE FILTER FABRIC, over compacted bedding.
3. Cover with general fill.
4. Fill up to subgrade elevation.
5. Compact in maximum 8 inch lifts to 95 percent of maximum dry density.

3.6 TOLERANCES
A. Top Surface of General Backfilling: Plus or minus 1 inch from required elevations.

3.7 FIELD QUALITY CONTROL
A. Perform compaction density testing on compacted fill in accordance with ASTM D1556, ASTM D2167, ASTM D6938, or ASTM D3017.
B. Evaluate results in relation to compaction curve determined by testing uncompacted material in accordance with ASSTM D698 (“Standard Proctor”), ASTM D1557 (“Modified Proctor”), or AASHTO T180.
C. If tests indicate work does not meet specified requirements, remove work, replace and retest.
D. Frequency of Tests; each lift.

3.8 CLEAN-UP
A. Leave unused materials in a neat compact stockpile.
B. Remove unused stockpiled material, leave area in a clean and neat condition. Grade stockpile areas to prevent standing surface water.
C. Leave borrow areas in a clean and neat condition. Grade to prevent standing surface water.

END OF SECTION
SECTION 31 23 16.20 – ROCK EXCAVATION

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes furnishing all labor, material and equipment to excavate rock and dispose of rock as specified herein.

B. Requirements of Regulatory Agencies:
   1. Observe all municipal ordinances and State and Federal laws relating to the transportation, storage, handling and use of explosives.
   2. Blasters shall be duly licensed and shall have their license on the work site at all times during blasting activities.

1.2 DEFINITION

A. At sites of utility relocation projects, rock excavation is hereby defined as material that cannot be removed with the normal excavation equipment used on the project. It is further defined as material requiring drilling and/or blasting prior to its removal from the trench site. The following do not qualify for rock excavation: (1) soft or disintegrated rock that can be removed with a hand pick, power-operated excavator, or shovel; (2) loose, broken, or previously blasted rock or broken stone in rock fills or elsewhere; and (3) rock which has fallen into the excavation from outside of the minimum limits of measurement allowed.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 EXCAVATION

A. Excavate rock to the lines and grades indicated on the drawings. Dispose of excavated material not suitable for backfill in a location approved by the Owner.

B. In rock, excavations shall be carried six inches (6 inches) below the bottom of the pipe. Loose earth or gravel not larger than three fourths of an inch (3/4 inches) in size shall be used for backfill, tamped thoroughly, and rounded to receive pipe as above.

C. Excavate rock in structure excavations to 6 inches below the bottom of the foundation.

3.2 MEASUREMENT AND PAYMENT

A. The contractor shall notify the owner when rock measurements can be performed. If backfill commences before measurement is made, the contractor will not be paid for that portion of the rock removed. Maximum measurement for rock excavation in pipe trenches shall be to six (6) inches below bottom of pipe with the width of trench at 2 feet plus the interior diameter of pipe, regardless of the excess width excavated. Maximum measurement for precast and cast-in-place structures shall be structure width plus four (4) feet; structure length plus four (4) feet; and base of structure. Payment shall be the price bid per cubic yard and is to include aggregate fill to bring the ditch to plan grade.

END OF SECTION
SECTION 31 23 19 – DEWATERING

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes: Work required to dewater excavations.

B. Related sections:
1. Section 01 50 00 – Temporary Facilities and Controls.

1.2 WATER CONTROL PLAN

A. As a minimum, include:
1. Descriptions of proposed groundwater and surface water control facilities including, but not limited to, equipment; methods; standby equipment and power supply, pollution control facilities, discharge locations to be utilized, and provisions for immediate temporary water supply as required by this section.
2. Drawings showing locations, dimensions, and relationships of elements of dewatering system.

B. If system is modified during installation or operation revise or amend and resubmit Water Control Plan.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 GENERAL

A. Remove and control surface and subsurface water during periods when necessary to properly accomplish Work.

3.2 SURFACE WATER CONTROL

A. See Section 01 50 00, TEMPORARY FACILITIES AND CONTROLS.

B. Remove surface runoff controls when no longer needed.

3.3 DEWATERING SYSTEMS

A. Provide, operate, and maintain dewatering systems of sufficient size and capacity to permit excavation and subsequent construction in dry and to lower and maintain groundwater level a minimum of 2 feet below the lowest point of excavation. Continuously maintain excavations free of water, regardless of source, and until backfilled to final grade.

B. Design and Operate Dewatering Systems:
1. To prevent loss of ground as water is removed.
2. To avoid inducing settlement or damage to existing facilities, completed Work, or adjacent property.
3. To relieve artesian pressures and resultant uplift of excavation bottom.
4. Prevent softening, loosening or otherwise disturbing the excavation subgrade.

C. Provide sufficient redundancy in each system to keep excavation free of water in event of component failure.
D. Provide supplemental ditches and sumps only as necessary to collect water from local seeps.

3.4 DISPOSAL OF WATER

A. Obtain discharge permit for water disposal from authorities having jurisdiction.

B. Treat water collected by dewatering operations, as required by regulatory agencies, prior to discharge.

C. Discharge water as required by discharge permit and in manner that will not cause erosion or flooding, or otherwise damage existing facilities, completed Work, or adjacent property.

D. The discharge of ground water into treatment facilities will not be permitted unless specifically authorized by the Owner. Remove solids from treatment facilities and perform other maintenance of treatment facilities as necessary to maintain their efficiency. If Owner allows groundwater discharge into facilities.

3.5 PROTECTION OF PROPERTY

A. Make assessment of potential for dewatering induced settlement. Provide and operate devices or systems, including but not limited to reinjection wells, infiltration trenches and cutoff walls, necessary to prevent damage to existing facilities, completed Work, and adjacent property.

B. Securely support existing facilities, completed Work, and adjacent property vulnerable to settlement due to dewatering operations. Support shall include, but not be limited to, sheeting bracing, underpinning, or compaction grouting.

3.6 REMEDIATION OF GROUNDWATER AFTER DEPLETION

A. If dewatering reduces quantity or quality of water produced by existing wells, temporarily supply water to affected well owners from other sources. Furnish water of a quality and quantity equal to or exceeding the quality and quantity available to the well owner prior to beginning Work or as satisfactory to each well owner.

END OF SECTION
SECTION 31 23 23.13 - FILL AND BACKFILL

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes: Work and materials required for fill and backfill for all excavations other than trench type excavations.

B. Related sections:
1. Section 03 30 00 – Cast-In-Place Concrete.
2. Section 31 11 00 – Site Preparation.
3. Section 31 22 13 – Subgrade Preparation.
4. Section 31 23 16 – Excavation.
5. Section 31 23 23.16 – Trench Backfill.
6. Section 32 11 00 – Base Course.

1.2 REFERENCES

A. The following is a list of standards which may be referenced in this section:
   c. ASTM D75, Standard Practice for Sampling Aggregates.
   d. ASTM D698, Standard Test Methods for Laboratory Characteristics of Soil Using Modified Effort (12,400 ft-lbf/ft³).
   e. ASTM D1556, Standard Test Method for Density of Soil in Place by the Sand Cone Method.
   f. ASTM D1557, Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft³).
   g. ASTM D6938, Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth).
   h. ASTM D4253, Standard Test Methods for Maximum Index Density and Unit Weight of Soils Using a Vibratory Table.
   i. ASTM D4254, Standard Test Methods for Minimum Index Density and Unit Weight of Soils and Calculation of Relative Density.

1.3 DEFINITIONS

A. Relative Compaction:
1. Ratio, in percent, of as-compacted field dry density to laboratory maximum dry density as determined in accordance with ASTM D698.
2. Apply corrections for oversize material to either as-compacted field dry density or maximum dry density, as determined by Engineer.

B. Optimum Moisture Content:
1. Determined in accordance with ASTM D698 specified to maximum dry density for relative compaction.
2. Determine field moisture content on basis of fraction passing 3/4-inch sieve.

C. Relative Density: Calculated in accordance with ASTM D4254 based on maximum index density determined in accordance with ASTM D4253 and minimum index density determined in accordance with ASTM D4254.
D. Prepared Ground Surface: Ground surface after completion of required demolition, clearing and grubbing, scalping of sod, stripping of topsoil, excavation to grade, and preparation.

E. Completed Course: A course or layer that is ready for next layer or next phase of Work.

F. Lift: Loose (uncompacted) layer of material.

G. Geosynthetics: Geotextiles, geogrids, or geomembranes.

H. Well-Graded:
   1. A mixture of particle sizes with no specific concentration or lack thereof of one or more sizes.
   2. Does not define numerical value that must be placed on coefficient of uniformity, coefficient of curvature, or other specific grain size distribution parameters.
   3. Used to define material type that, when compacted, produces a strong and relatively incompressible soil mass free from detrimental voids.

I. Influence Area: Area within planes sloped downward and outward at 60-degree angle from horizontal measured from:
   1. 1-foot outside outermost edge at base of foundations or slabs.
   2. 1-foot outside outermost edge at surface of roadways or shoulder.
   3. 0.5-foot outside exterior at spring line of pipes or culverts.

J. Borrow Material: Material from required excavations or from designated borrow areas on or near site.

K. Selected Backfill Material/Earthfill/Engineered Fill: Materials available onsite that Engineer determines to be suitable for specific use.

L. Imported Material: Materials obtained from sources suitable for specified use.

M. Structural Fill: Fill materials as required under structures, pavements, and other facilities.

N. Embankment Material: Fill materials required to raise existing grade in areas other than under structures.


1.4 SUBMITTALS

A. Quality Control Submittals:
   1. Catalog and manufacturer’s data sheets for compaction equipment.
   2. Certified test results from independent testing agency.

1.5 QUALITY ASSURANCE

A. Notify Engineer when:
   1. Structure is ready for backfilling, and whenever backfilling operations are resumed after a period of inactivity.
   2. Soft or loose subgrade materials are encountered wherever embankment or site fill is to be placed.
   3. Fill material appears to be deviating from Specifications.
1.6 SEQUENCING AND SCHEDULING

A. Complete applicable Work specified in Sections 31 11 00, SITE PREPARATION; 31 23 16, EXCAVATION; and 31 22 13, SUBGRADE PREPARATION, prior to placing fill or backfill.

B. Backfill against concrete structures only after concrete has attained compressive strength, specified in Section 03 30 00, CAST-IN-PLACE CONCRETE. Obtain acceptance of concrete work and attained strength prior to placing backfill.

C. Backfill around water-holding structures only after completion of satisfactory leakage tests as specified in Section 03 30 00, CAST-IN-PLACE CONCRETE.

D. Do not place granular base, subbase, or surfacing until after subgrade has been prepared as specified in Section 31 22 13, SUBGRADE PREPARATION.

PART 2 - PRODUCTS

2.1 SOURCE QUALITY CONTROL

A. Gradation Tests: It will be the Contractor’s responsibility to conduct testing as necessary to locate acceptable sources of imported material.

2.2 EARTH FILL

A. Excavated material from required excavations, free from rocks larger than 3 inches, from large roots and other organic matter greater than 3% by weight, ashes, cinders, trash, debris and other deleterious materials.

2.3 ENGINEERED FILL

A. Earth fill as described above or imported fill from off site.

B. Maximum gravel and oversize particle content: 5% retained on a ¾ - inch sieve.

C. Percent passing No. 200 sieve between 35% and 70%.

D. Liquid limit <40, PI <18.

2.4 GRANULAR FILL

A. ALDOT Class 57 unless indicated otherwise in the plans.

2.5 WATER FOR MOISTURE CONDITIONING

A. Free of hazardous or toxic contaminants, or contaminants deleterious to proper compaction.

2.6 BASE COURSE ROCK

A. As specified in Section 32 11 00, BASE COURSE.

2.7 FOUNDATION STABILIZATION ROCK

A. Crushed rock or pit run rock.

B. Uniformly graded from coarse to fine.
C. Free from excessive dirt and other organic material.
D. Maximum 2-1/2 inches particle size.

PART 3 - EXECUTION

3.1 GENERAL

A. Keep placement surfaces free of water, debris, and foreign material during placement and compaction of fill and backfill materials.

B. Place and spread fill and backfill materials in horizontal lifts of uniform thickness, in a manner that avoids segregation, and compact each lift to specified densities prior to placing succeeding lifts. Slope lifts only where necessary to conform to final grades or as necessary to keep placement surfaces drained of water.

C. During filling and backfilling, keep level of fill and backfill around each structure and buried tank even.

D. Do not place fill or backfill, if fill or backfill material is frozen, or if surface upon which fill or backfill is to be placed is frozen.

E. If pipe, conduit, duct bank, or cable is to be laid within fill or backfill:
   1. Fill or backfill to an elevation 2 feet above top of item to be laid.
   2. Excavate trench for installation of item.
   3. Install bedding, if applicable, as specified in Section 31 23 23.16, TRENCH BACKFILL.
   4. Install item.
   5. Backfill envelope zone and remaining trench, as specified in Section 31 23 23.16, TRENCH BACKFILL, before resuming filling or backfilling specified in this section.

F. Tolerances:
   1. Final Lines and Grades: Within a tolerance of 0.1-foot unless dimensions or grades are shown or specified otherwise.
   2. Grade to establish and maintain slopes and drainage as shown. Reverse slopes are not permitted.

G. Settlement: Correct and repair any subsequent damage to structures, pavements, curbs, slabs, piping, and other facilities, caused by settlement of fill or backfill material.

H. Fill and backfill materials shall be conditioned to a water content that is within 2 percentage points (plus or minus) of the optimum required for compaction as determined by ASTM D698.

3.2 BACKFILL UNDER AND AROUND STRUCTURES

A. Under Facilities: Within influence area beneath structures, slabs, pavements, curbs, piping, conduits, duct banks, and other facilities, backfill with granular fill, unless otherwise shown. Place granular fill in lifts of 6-inch maximum thickness and compact each lift to minimum of 98 percent relative compaction as determined in accordance with ASTM D698, Method C. Moisture condition at time of compaction to within ±3 percent of the material's optimum moisture content.

B. Subsurface Drainage: Backfill with granular drain material, where shown. Place granular drain material in lifts of 6-inch maximum thickness and compact each lift to minimum of 90 percent relative density.
C. Other Areas: Backfill with engineered fill to lines and grades shown, with proper allowance for topsoil thickness where shown. Place in lifts of 6-inch maximum thickness and compact each lift to minimum 95 percent relative compaction as determined in accordance with ASTM D698, Method C.

3.3 FILL

A. Outside Influence Areas Beneath Structures, Tanks, Pavements, Curbs, Slabs, Piping, and Other Facilities: Unless otherwise shown, place earthfill as follows:
1. Allow for 6-inch thickness of topsoil where required.
2. Maximum 8-inch thick lifts.
3. Place and compact fill across full width of embankment.
4. Compact to minimum 95 percent relative compaction as determined in accordance with ASTM D698, Method C.
5. Dress completed embankment with allowance for topsoil, crest surfacing, and slope protection, where applicable.

3.4 SITE TESTING

A. Gradation:
1. One sample from each 400 tons of finished product or more often as determined by Engineer, if variation in gradation is occurring, or if material appears to depart from Specifications.
2. If test results indicate material does not meet Specification requirements, terminate material placement until corrective measures are taken.
3. Remove material placed in Work that does not meet Specification requirements.

B. In-Place Density Tests: In accordance with ASTM. During placement of materials, test as follows:
1. One field density test every 1,000 square feet per lift, minimum 2 per lift within building footprint.
2. One test per every other lift per 200 lineal feet, per lift of roadway or trench.
3. A minimum of two test per 300 cubic yards during backfilling of walls.

C. Testing shall be the Contractor’s responsibility and conducted by persons experienced in such work.

3.5 GRANULAR BASE, SUBBASE, AND SURFACING

A. Place and Compact as specified in Section 32 11 00, BASE COURSE.

3.6 REPLACING OVEREXCAVATED MATERIAL,

A. Replace excavation carried below grade lines shown or established by Engineer as follows:
1. Beneath Footings: Concrete of strength equal to that of respective footing.
2. Beneath Fill or Backfill: Same material as specified for overlying fill or backfill.
4. Trenches:
   a. Unauthorized Overexcavation: Either trench stabilization material or granular pipe base material, as specified in Section 31 23 23.16, TRENCH BACKFILL.
   b. Authorized Overexcavation: Trench stabilization material, as specified in Section 31 23 23.16, TRENCH BACKFILL.
5. Permanent Cut Slopes (Where Overlying Area is Not to Receive Fill or Backfill):
   a. Flat to Moderate Steep Slopes (3: 1, Horizontal Run: Vertical Rise or Flatter): Earthfill.
b. Steep Slopes (Steeper than 3:1):
   1) Correct overexcavation by transitioning between areas and designed slope adjoining areas, provided such cutting does not extend offsite or outside easements and right-of-ways, or adversely impacts existing facilities, adjacent property, or completed Work.
   2) Backfilling overexcavated areas is prohibited unless, in opinion, backfill will remain stable, and overexcavated material is replaced as compacted earth fill.

END OF SECTION
SECTION 31 23 23.16 - TRENCH BACKFILL

PART 1 - GENERAL

1.1 REFERENCES

A. The following is a list of standards which may be referenced in this section:
      a. ASTM D448, Standard Classification for Sizes of Aggregate for Road and Bridge Construction.
      f. ASTM C618, Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete.
      g. ASTM D422, Standard Test Method for Particle-Size Analysis of Soils.
      h. ASTM D698, Standard Test Methods for Laboratory Compaction Characteristics of Soil using Standard Effort (12,400 ft-lbf/cubic ft).
      i. ASTM D1140, Standard Test Methods for Amount of Material in Soils Finer than the No. 200 (75 micrometer) Sieve.
      j. ASTM D1557, Standard Test Methods for Laboratory Compaction Characteristics of Soil using Modified Effort (56,000 ft-lbf).
      k. ASTM D3776, Standard Test Methods for Mass per Unit Area (Weight) of Fabric.
      m. ASTM D4253, Standard Test Methods for Maximum Index Density and Unit Weight of Soils Using a Vibratory Table.
      s. ASTM D5034, Standard Test Method for Breaking Strength and Elongation of Textile Fabrics (Grab Test).

1.2 DEFINITIONS

A. Base Rock: Granular material upon which manhole bases and other structures are placed.

B. Bedding Material: Granular material upon which pipes, conduits, cables, or duct banks are placed.

C. Imported Material: Material obtained by the Contractor from source(s) offsite.

D. Lift: Loose (uncompacted) layer of material.
E. Pipe Zone: Backfill zone that includes full trench width and extends from prepared trench bottom to an upper limit above top outside surface of pipe, conduit, cable or duct bank.

F. Prepared Trench Bottom: Graded trench bottom after stabilization and installation of bedding material.

G. Relative Compaction: The ratio, in percent, of the as-compacted field dry density to the laboratory maximum dry density as determined by ASTM D698. Corrections for oversize material may be applied to either the as-compacted field dry density or the maximum dry density, as determined by the Engineer.

H. Relative Density: As defined by ASTM D4253 and ASTM D4254.

I. Selected Backfill Material: Material available that the Engineer determines to be suitable for a specific use.

J. Well-Graded: A mixture of particle sizes that has no specific concentration or lack thereof of one or more sizes producing a material type that, when compacted, produces a strong and relatively incompressible soil mass free from detrimental voids. Well-Graded does not define any numerical value that must be placed on the coefficient of uniformity, coefficient of curvature, or other specific grain size distribution parameters.

1.3 SUBMITTALS

A. Shop Drawings: Manufacturer's descriptive literature for marking tapes.

B. Samples:
1. Trench stabilization material.
2. Bedding and pipe zone material.
5. Earth backfill.
6. Sand(s).
7. Geotextile.

C. Quality Control Submittals: Catalog and manufacturer's data sheets for compaction equipment.

D. Certified Gradation Analysis: Submit not less than 30 days prior to delivery for imported materials or anticipated use for excavated materials, except for trench stabilization material that will be submitted prior to material delivery to site.

E. Controlled Low Strength Material: Certified mix design and test results. Include material types and weight per cubic yard for each component of mix.

PART 2 - PRODUCTS

2.1 MARKING TAPE

A. Plastic:
1. Inert polyethylene, impervious to known alkalis, acids, chemical reagents, and solvents likely to be encountered in soil.
2. Thickness: Minimum 4 mils.
3. Width: 12 inches.
4. Identifying Lettering: Minimum 1-inch high, permanent black lettering imprinted continuously over entire length.
5. Manufacturers and Products:
   a. Reef Industries; Terra Tape.
   b. Allen; Markline.

B. Metallic:
   1. Solid aluminum foil, visible on unprinted side, encased in a protective high visibility, inert polyethylene plastic jacket.
   2. Thickness: Minimum 5 mils.
   3. Width: 12 inches.
   4. Identifying Lettering: Minimum 1-inch high, permanent black lettering imprinted continuously over entire length.
   5. Joining Clips: Tin or nickel-coated, furnished by tape manufacturer.
   6. Manufacturers and Products:
      a. Reef Industries; Terra Tape Sentry Line.
      b. Allen; Detectatape.

C. Color: In accordance with APWA Uniform Color Code for Temporary Marking of Underground Facilities.

<table>
<thead>
<tr>
<th>Color</th>
<th>Facility</th>
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</thead>
<tbody>
<tr>
<td>Red</td>
<td>Electric power lines, cables, conduit, and lightning cables</td>
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<tr>
<td>Orange</td>
<td>Communicating alarm or signal lines, cables, or conduit</td>
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<tr>
<td>Yellow</td>
<td>Gas, oil, steam, petroleum, or gaseous materials</td>
</tr>
<tr>
<td>Green</td>
<td>Sewers and drain lines</td>
</tr>
<tr>
<td>Blue</td>
<td>Water, irrigation, and slurry lines</td>
</tr>
</tbody>
</table>

*As specified in ANSI Z53.1, Safety Color Code.

2.2 TRENCH STABILIZATION MATERIAL

A. Clean, hard, durable 3-inch minus crushed rock gravel, or pit run, free from clay balls, other organic materials, or debris.

B. Uniformly graded from coarse to fine, less than 8 percent by weight passing the 1/4-inch sieve.

2.3 BEDDING MATERIAL AND PIPE ZONE MATERIAL

A. Unfrozen, friable, and no clay balls, roots, or other organic material.

B. Clean or gravelly sand with less than 5 percent passing No. 200 sieve, as determined in accordance with ASTM D1140, or gravel or crushed rock within maximum particle size and other requirements as follows unless otherwise specified.
   1. Duct Banks: 3/4-inch maximum particle size.
   2. PVC Irrigation System Piping, and Ductile Iron Pipe with Polyethylene Wrap: 3/8-inch maximum particle size.
   3. Pipe Under 18 Inches Diameter: 3/4-inch maximum particle size, except 1/4-inch for stainless steel pipe, copper pipe, tubing, and plastic pipe under 3 inches diameter.
   4. Pipe Greater than 18 Inches Diameter: 1-1/2-inch maximum particle size for ductile iron pipe, concrete pipe, welded steel pipe, and pretensioned or prestressed concrete cylinder pipe. 3/4-inch maximum particle size for PVC, FRP, or HDPE Pipe.
   5. Perforated Pipe: Granular drain material.
   6. Conduit and Direct-Buried Cable:
      a. Sand, clean or clean to silty, less than 12 percent passing the No. 200 sieve.
c. Maximum Size Particle: Pass a No. 4 sieve.
d. If more than 5 percent passes No. 200 sieve, the fraction that passes No. 40 sieve shall be nonplastic as determined in accordance with ASTM D4318.

2.4 EARTH FILL
A. As specified in Section 31 23 23.13, FILL AND BACKFILL.

2.5 CONTROLLED LOW STRENGTH FILL
A. Select and proportion ingredients to obtain compressive strength between 50 and 150 psi at 28 days in accordance with ASTM D4832.
B. Materials:
   1. Cement: ASTM C150, Type I or II.
   3. Fly Ash (if used): ASTM C618, Class C.
   4. Water: Clean, potable, containing less than 500 ppm of chlorides.

2.6 CONCRETE BACKFILL
A. Provide as specified in Section 03 30 00, CAST-IN-PLACE CONCRETE.

2.7 TOPSOIL
A. Topsoil removed and stockpiled from onsite excavation.

2.8 SOURCE QUALITY CONTROL
A. Perform gradation analysis in accordance with ASTM C136 for:
   1. Earth backfill, including specified class(es).
   2. Trench stabilization material.
   3. Bedding and pipe zone material.
B. Certify Laboratory Performance of Mix Designs:
   1. Controlled low strength fill.
   2. Concrete.

PART 3 - EXECUTION

3.1 TRENCH PREPARATION
A. Water Control: Conform to Section 31 23 19, DEWATERING.
   1. Promptly remove and dispose of water entering trench as necessary to grade trench bottom and to compact backfill and install manholes, pipe, conduit, direct-buried cable, or duct bank. Do not place concrete, lay pipe, conduit, direct-buried cable, or duct bank in water.
   2. Remove water in a manner that minimizes soil erosion from trench sides and bottom.
   3. Provide continuous water control until trench backfill is complete.
B. Remove foreign material and backfill contaminated with foreign material that falls into trench.
3.2 TRENCH BOTTOM

A. Firm Subgrade: Grade with hand tools, remove loose and disturbed material, and trim off high areas and ridges left by excavating bucket teeth. Allow space for bedding material if shown or specified.

B. Soft Subgrade: If it is encountered that it may require removal to prevent pipe settlement, notify Engineer. Engineer will determine the depth of overexcavation, if any, required.

3.3 TRENCH STABILIZATION MATERIAL INSTALLATION

A. Rebuild trench bottom with trench stabilization material.

B. Place material over full width of trench in 6-inch lifts to required grade, providing allowance for bedding thickness.

C. Compact each lift so as to provide a firm, unyielding support for the bedding material prior to placing succeeding lifts.

3.4 BEDDING

A. Furnish imported bedding material where, in the opinion of the Engineer, excavated material unsuitable for bedding or insufficient in quantity.

B. Place over the full width of the prepared trench bottom in two equal lifts when the required depth exceeds 8 inches.

C. Hand grade and compact each lift to provide a firm, unyielding surface.

D. Minimum Thickness:
   2. Pipe, 18-inch to 36 inch: 6 inches.
   4. Conduit: 3 inches.
   5. Direct-Buried Cable: 3 inches.
   6. Duct Banks: 3 inches.

E. Check grade and correct irregularities in bedding material. Loosen top 1 to 2 inches of compacted bedding material with a rake or by other means to provide a cushion before laying each section of pipe, conduit, direct-buried cable, or duct bank.

F. Install to form continuous and uniform support except at bell holes, if applicable, or minor disturbances resulting from removal of lifting tackle.

G. Bell or Coupling Holes: Excavate in bedding at each joint to permit proper assembly and inspection of joint and to provide uniform bearing along barrel of pipe or conduit.

3.5 BACKFILL PIPE ZONE

A. Upper limit of pipe zone shall not be less than following:
   1. Pipe: 12 inches above top of pipe, unless shown otherwise.
   2. Conduit: 3 inches above top of conduit, unless shown otherwise.
   3. Direct-Buried Cable: 3 inches above top of cable, unless shown otherwise.
   4. Duct Bank: 3 inches above top of duct bank, unless shown otherwise.
B. Restrain pipe, conduit, cables, and duct banks as necessary to prevent their movement during backfill operations.

C. Place material simultaneously in lifts on both sides of pipe and, if applicable, between pipes, conduit, cables, and duct banks installed in same trench.
   1. Pipes 10 Inches and Smaller Diameter: First lift less than or equal to pipe-diameter.
   2. Pipes Over 10 Inches Diameter: Maximum 6-inch lifts.

D. Thoroughly tamp each lift, including area under haunches, with handheld tamping bars supplemented by "walking in" and slicing material under haunches with a shovel to ensure that voids are completely filled before placing each succeeding lift.

E. After the full depth of the pipe zone material has been placed as specified, compact the material by a minimum of three passes with a vibratory plate compactor only over the area between the sides of the pipe and the trench walls.

F. Do not use power-driven impact compactors to compact pipe zone material.

3.6 MARKING TAPE INSTALLATION

A. Continuously install marking tape along centerline of all buried piping, at depth of 2 feet. Coordinate with piping installation drawings.
   1. Metallic Marking Tape: Install with nonmetallic piping

3.7 BACKFILL ABOVE PIPE ZONE

A. General:
   1. Process excavated material to meet specified gradation requirements.
   2. Adjust moisture content as necessary to obtain specified compaction.
   3. Do not allow backfill to free fall into the trench or allow heavy, sharp pieces of material to be placed as backfill until after at least 2 feet of backfill has been provided over the top of pipe.
   4. Do not use power driven impact type compactors for compaction until at least 4 feet of backfill is placed over top of pipe.
   5. Backfill to grade with proper allowances for topsoil, crushed rock surfacing, and pavement thicknesses, wherever applicable.
   6. Backfill around structures with same class backfill as specified for adjacent trench unless otherwise shown or specified.

B. Select Excavated Backfill:
   1. Place in lifts not exceeding 9-inch thickness.
   2. Mechanically compact each lift to a minimum of 95 percent relative compaction prior to placing succeeding lifts.

C. Excavated Backfill: Backfill trench above the pipe zone with granular backfill in lifts not exceeding 8 inches. Compact each lift to a minimum of 95 percent relative compaction prior to placing succeeding lifts.

D. Concrete Backfill:
   1. Place above bedding.
   2. Minimum Concrete Thickness: 6 inches on top and sides of pipe.
   3. Do not allow dirt or foreign material to become mixed with concrete during placement.
   4. Allow sufficient time for concrete to reach initial set before additional backfill material is placed in trench.
5. Prevent flotation of pipe.
6. Begin and end concrete backfill within 4 inches of a pipe joint on each end.
7. Do not encase pipe joints except within the limits of the concrete backfill.

E. Controlled Low Strength Fill:
   1. Discharge from truck mounted drum type mixer into trench.
   2. Place in lifts as necessary to prevent uplift (flotation) of new and existing facilities.

3.8 REPLACEMENT OF TOPSOIL

A. Replace topsoil in top 6 inches of backfilled trench.

B. Maintain the finished grade of topsoil even with adjacent area and grade as necessary to restore drainage.

3.9 MAINTENANCE OF TRENCH BACKFILL

A. After each section of trench is backfilled, maintain the surface of the backfilled trench even with the adjacent ground surface until final surface restoration is completed.

B. Gravel Surfacing Rock: Add gravel surfacing rock where applicable and as necessary to keep the surface of the backfilled trench even with the adjacent ground surface, and grade and compact as necessary to keep the surface of backfilled trenches smooth, free from ruts and potholes, and suitable for normal traffic flow.

C. Topsoil: Add topsoil where applicable and as necessary to maintain the surface of the backfilled trench level with the adjacent ground surface.

D. Asphaltic Pavement: Replace settled areas or fill with asphalt as specified in Section 32 12 16, ASPHALT CONCRETE PAVEMENT.

E. Other Areas: Add excavated material where applicable and keep the surface of the backfilled trench level with the adjacent ground surface.

3.10 SETTLEMENT OF BACKFILL

A. Settlement of trench backfill, or of fill or facilities constructed over trench backfill, will be considered a result of defective compaction of trench backfill.

END OF SECTION
SECTION 31 23 23.33 – CONTROLLED LOW STRENGTH MATERIAL (CLSM)

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specifications, apply to this Section.

1.2 SUMMARY

A. This Section specifies concrete controlled low strength material (CLSM).

B. Comply with all requirements of Section 03 30 00 CAST-IN-PLACE CONCRETE except as specifically modified in this Section.

1.3 RELATED SECTIONS

A. Section 03 30 00 CAST-IN-PLACE CONCRETE.

1.4 DEFINITIONS

A. CLSM: Controlled low strength concrete ready mix.

1.5 SUBMITTALS

A. Comply with the requirements of Section 03 30 00 CAST-IN-PLACE CONCRETE.

1.6 QUALITY ASSURANCE

A. Comply with the requirements of Section 03 30 00 CAST-IN-PLACE CONCRETE.

PART 2 - PRODUCTS

2.1 PRODUCTS

A. Comply with the requirements of Section 03 30 00 CAST-IN-PLACE CONCRETE and as follows:

1. Concrete Mixture for CLSM only:
   a. Compressive strength 75 to 100 psi.
   b. Cement 80-100 lbs per CY.
   c. Fly Ash 200-300 lbs per CY.
   d. Sand variable to equal one CY.
   e. Water 65 to 199 gallons per CY.
   f. Unit weight approximately 110 lbs/CY.

PART 3 - EXECUTION

3.1 EXECUTION

A. Comply with the requirements of Section 03 30 00 CAST-IN-PLACE CONCRETE.

END OF SECTION
SECTION 31 32 00 - SOIL EROSION STABILIZATION

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes: Work and materials required to minimize erosion and comply with Storm Water Pollution Prevention Plan.

1.2 STABILIZATION

A. Soil Erosion Stabilization:
   1. Ground surfaces exposed during the wet weather conditions:
   2. Areas which will not be subjected to heavy wear by ongoing construction traffic.
   3. Temporary and long term stabilization of new or disturbed ditches, swales, detention ponds, or disturbed ground with intermittence construction traffic.

B. Permanent Stabilization:
   1. Permanently stabilize exposed soil surfaces at finished grades.
   2. Permanent stabilization methods include, but are not limited to, seeding (permanent), mulching, and landscaping.
   3. Immediately perform permanent stabilization at each completed excavation and areas except for areas that are scheduled to be redisturbed.
   4. Incorporate all permanent erosion control features into the project at the earliest practical time.

C. Buffer Zone: Undisturbed area or strip of natural vegetation or an established suitable planting adjacent to a disturbed area that reduces erosion and runoff.


1.3 SUBMITTALS

A. Shop Drawings: Product Data for the following items
   1. Erosion control rock.
   2. Fertilizer.
   3. Seed.
   4. Mulch.
   5. Erosion control rock.
   7. Reinforced plastic covering.
   8. Silt fence.
   11. Dust controller.
   12. Wire mesh.

1.4 DELIVERY, STORAGE, AND PROTECTION

A. General: Prevent or reduce the discharge of pollutants to stormwater from all material delivery and storage by minimizing the storage of hazardous materials storing materials in a designated area, installing Secondary containment, conducting regular inspection, and training employees and subcontractors.
B. Seed:
1. Furnish in standard containers with seed name, lot number, net weight, percentages of purity, germination, and hard seed and maximum weed seed content, clearly marked for each container of seed.
2. Keep dry during storage.

C. Hydroseeding Mulch: Mark package of wood fiber mulch to show air dry weight.

1.5 SEQUENCING AND SCHEDULING
A. Install erosion and sediment control devices before starting earth disturbance activities and as drainage facilities get constructed.

B. Complete Soil Preparation: Seeding, fertilizing, mulching and matting on disturbed areas that will require stabilization either because the area has reached final grade (permanent landscaping) or because the area will remain unworked for over 14 days (temporary seeding) during the wet season.

C. Notify Engineer at least 3 days in advance of:
   1. Materials delivery.
   2. Start of stabilization activity.

D. Seeding: Perform between March 15 and September 15.

1.6 MAINTENANCE
A. Operations:
   1. Seeded Areas: Perform during maintenance period to include:
      a. Watering: Keep seeded surface moist.
      b. Washouts: Repair by filling with topsoil, fertilizing, seeding, and mulching.
      c. Mulch: Replace wherever and whenever washed or blown away.
      d. Reseed unsatisfactory areas or portions thereof immediately at the end of the maintenance period if a satisfactory stand has not been produced.
      e. Reseed during next planting season if scheduled end of maintenance period falls after September 15.
      f. Reseed entire area if satisfactory stand does not develop by July 1 of the following year.
      g. Mowing: Mow to 2 inches after grass height reaches 3 inches, and mow to maintain grass height from exceeding 3-1/2 inches.
   2. Inspect, repair, and replace as necessary all erosion control measures during the time period from start of construction to completion of construction.
   3. Inspect a minimum of at least once every 7 days or after a 1/2-inch storm event in a 24-hour period.
   4. Furnish and install a rain gauge at the project site to monitor rainfall. At no time shall more than 1-foot depth of sediment be allowed to accumulate in any erosion control device.

B. Sediment Removal:
   1. Remove sediment from erosion control devices and work into the grading plan at least once a week as required to maintain proper operation of devices. The cleaning operation shall not dispose of sediment offsite
   2. Sediment shall be removed and the controls upgraded or repaired as needed as soon as practicable, but not later than 2 days after the surrounding exposed ground has dried sufficiently to prevent further damage from equipment needed for repair operations.
3. In the event of continuous rainfall over a 24-hour period, or other circumstances that preclude equipment operation in the area, hand carry and install additional sediment controls as approved by the Engineer.

PART 2 - PRODUCTS

2.1 FERTILIZER

A. Commercial, uniform in composition, free-flowing, suitable for application with equipment designed for that purpose.

B. Fertilizer shall have the following minimum percentage of plant food by weight:
   1. Summer Hydroseed Mix:
      b. Phosphoric Acid: 10 percent.
      c. Potash: 10 percent.
   2. Winter Hydroseed Mix:
      b. Phosphoric Acid: 8 percent.
      c. Potash: 0 percent.

2.2 SEED

A. Common Bermuda grass meeting the requirements of the specifications of the Alabama Department of Transportation (ALDOT).

2.3 MULCH

A. Wood Cellulose Fiber Mulch:
   1. Specially processed wood fiber containing no growth or germination inhibiting factors.
   2. Dyed a suitable color to facilitate inspection of material placement.
   3. Manufactured such that after addition and agitation in slurry tanks with water, the material fibers will become uniformly suspended to form a homogenous slurry.
   4. When hydraulically sprayed on ground, material will allow absorption and percolation of moisture.

B. Straw:
   1. Clean salt hay or threshed straw of oats, wheat, barley, or rye, free from seed of noxious weeds. Suitable for spreading with mulch blower equipment.
   2. Average Stalk Length: 6 inches.
   3. Seasoned before baling or loading.

2.4 EROSION CONTROL MATTING

A. Excelsior mat or straw blanket; staples as recommended by matting manufacturer.

B. Manufacturers and Products:
   1. American Excelsior Company, Dallas, TX; Curlex Mat.
   2. North American Green, Evansville, IN; S150 blanket.

2.5 REINFORCED PLASTIC COVERING

A. Co-extruded, copolymer laminate reinforced with a nonwoven grid of high strength nylon cord submersed in a permanently flexible adhesive media allowing for equal tear resistance in all directions.
B. Black in color and ultraviolet stabilized.

C. Physical Requirement (Minimum Average Roll Values):
   1. Tear Strength: 130 pounds.
   2. Elongation: 620 percent.

D. Manufacturers:
   1. Reef Industries, Inc., Houston, TX.
   2. Griffolyn Co., Houston, TX.

2.6 SILT FENCE

A. Support Posts: As recommended by manufacturer of geotextile.

B. Fasteners: Heavy-duty wire staples at least 1-inch long, tie wires, or hog rings, as recommended by manufacturer of geotextile.

C. Filter Fabric: Polyester, polypropylene, or nylon filaments, woven into a uniform pattern, distinct and measurable openings.
   1. Filaments: Resistant to damage from exposure to ultraviolet rays and heat.
   2. Material Edges: Finish so that, filaments retain their relative positions under stress.

D. In accordance with the following properties:

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<tr>
<th>Physical Property</th>
<th>Required Value</th>
<th>Test Method</th>
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<td>Equivalent Opening Size, max.</td>
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<td>U.S. Standard Sieve</td>
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<td>Grab Tensile Strength, lb, min. ARV</td>
<td>160</td>
<td>ASTM D4632</td>
</tr>
<tr>
<td>Elongation, % max.</td>
<td>25</td>
<td>ASTM D1682</td>
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<tr>
<td>Mullen Burst Strength, psi, min. ARV</td>
<td>200</td>
<td>ASTM D3786</td>
</tr>
<tr>
<td>Ultraviolet Radiation Resistance, %</td>
<td>70</td>
<td>ASTM D4355</td>
</tr>
<tr>
<td>Strength Retention</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Flow Rate, gpm/sf, min. ARV</td>
<td>30 to 50</td>
<td>ASTM D4491</td>
</tr>
</tbody>
</table>

E. Manufacturers:
   1. Polyfelt, Evergreen, AL.
   2. Dupont Co., Wilmington, DE.
   3. Mirafi, Inc., Charlotte, NC.

2.7 STRAW BALES

A. Machine baled clean salt hay or straw of oats, wheat, barley, or rye, free from seed of noxious weeds, using standard baling wire or string.

2.8 POSTS FOR STRAW BALES

A. 2-inch by 2-inch untreated wood or commercially manufactured metal.

2.9 DUST CONTROLLER

A. Nontoxic materials that do not have an adverse effect on soil structure or establishment and growth of vegetation.
PART 3 - EXECUTION

3.1 GENERAL

A. Erosion control measures are required during all construction and site disturbance activity and shall remain until permanent site ground covers are in place.

B. The implementation of the erosion control plan and the construction maintenance, replacement and upgrading the erosion control devices are the responsibility of the Contractor until all construction is completed and landscaping established and approved. During the construction period, the erosion control devices shall be upgraded for unexpected storm events and to ensure that sediment and sediment laden water do not leave the site.

C. Maintain existing buffer zones adjacent to project limits. Keep all construction equipment, debris and soils out of the natural buffer zone.

3.2 GRAVEL CONSTRUCTION ENTRANCES

A. Provide a graveled construction access at each access point between the site and any public or private road or other paved surface.

B. Place subgrade geotextile, as specified, on the ground prior to erosion control rock placement.

C. Place erosion control rock over the geotextile to a minimum thickness of 8 inches.

D. Minimum dimensions for construction entrances are 50-foot in length by 16-foot width.

E. Contractor shall provide a minimum of 4 inches of erosion control rock for each entrance 3 times during the project at times directed by the Engineer to maintain proper function. More frequent applications of rock may be required, and if so, shall be considered as incidental work.

3.3 SOIL PREPARATION

A. Before start of hydroseeding, and after surface has been shaped and graded, and lightly compacted to uniform grade, scarify soil surface to minimum depth of 1 inch.

3.4 FERTILIZER

A. Apply evenly over area in accordance with manufacturer's instructions. Mix into top 1-inch of soil.

B. Application Rate: 5 pounds per 1,000 square foot over areas to be seeded. Use of approved hydraulic equipment to sow seed and distribute fertilizer at the same time will be acceptable.

3.5 SEEDING

A. Prepare 1-inch depth seed bed; obtain Engineer's acceptance prior to proceeding.

B. Apply by hydroseeding method on moist soil, but only after free surface water has drained away. Prevent drift and displacement of mixture into other areas.

C. Summer Application:
   1. Prepare and apply slurry as follows:
### Item | Rate
--- | ---
Seed Mix | 200 pounds per acre
Fertilizer | 750 pounds per acre
Wood Cellulose Fiber Mulch | As recommended by manufacturer
Water | As necessary

2. Irrigation: 1-inch per week to seeded areas.

### 3.6 MULCHING

A. Apply uniformly on disturbed areas that will remain undisturbed for 7 days or more, as requested by Engineer, and on all seeded areas.

B. Application: Sufficiently loose to permit penetration of sunlight and air circulation, and sufficiently dense to shade ground, reduce evaporation rate, and prevent or materially reduce erosion of underlying soil.
   1. Straw: Apply by hand or mechanical means to minimum depth of 2 inches.
   2. Wood Cellulose Fiber: 1,000 to 1,500 pounds per acre.

### 3.7 EROSION CONTROL MATTING

A. Place on seeded slopes 4H:1V and steeper.

B. Apply seed and fertilizer prior to matting.

C. At top of slope, entrench material in a 6-inch by 6-inch trench and staple at 1-foot intervals. At the bottom of the slope, extend the mat 2 feet beyond the toe of slope, turn material under 4 inches and staple at 1-foot intervals.

D. Mats shall be stapled in place as they are installed down the slope face. The mat shall have direct contact with the soil surface.

E. Overlap:
   1. Lengthwise: 1-foot minimum.

### 3.8 REINFORCED PLASTIC COVERING

A. Place on areas where hydroseeding and erosion control matting have not controlled erosion and over all temporary stockpiles.

B. Install in single thickness, strips parallel to direction of drainage. Anchor plastic in 6-inch by 6-inch trench backfilled with compacted native material

C. Maintain tightly in place by using sandbags on ropes with a maximum 10-foot grid spacing in all directions.

D. Tape or weight down full length, overlap seams at least 12 inches.

E. Remove at final acceptance unless notified otherwise by Engineer.

### 3.9 SILT FENCE

A. Install prior to starting earth disturbing activities upslope of fence.
B. One-piece filter fabric or continuously sewn to make one-piece filter fabric for full height of the fence, including portion buried in the toe trench.

C. When joints are necessary, splice filter fabric together only at a support post, with a minimum 6-inch overlap, and securely fasten both ends to support post.

D. Filter fabric shall not extend more than 24 inches above the ground surface. Securely fasten to upslope side of each support post using ties. Filter fabric shall not be stapled to existing trees.

E. Fasten wire mesh material support fence securely to upslope side of post fasteners. Extend wire into the trench a minimum of 4 inches, and not more than 36 inches above the ground surface.

F. Take precaution not to puncture filter fabric during installation. Repair or replace damaged area.

G. Remove silt fence after upslope area has been permanently stabilized. Immediately dress sediment deposits remaining after the silt fence has been removed to conform to existing grade. Prepare and seed graded area.

3.10 TEMPORARY SOIL STOCKPILES

A. Cover with reinforced plastic covering, as directed in Article REINFORCED PLASTIC COVERING.

B. Protect perimeter of stockpile from erosion with ditches.

3.11 STRAW BALES

A. Embed minimum of 4 inches in flat-bottomed trench. Place across swales or ditches to reduce velocities of concentrated flows. Space bales a minimum of 100-foot spacing.

B. Place with ends tightly abutting or overlapped. Corner abutment is not acceptable.

C. Install so that bale bindings are oriented around the sides and not over the top and bottom of the bale.

D. Use two posts for each bale. Drive posts through the bale until top of post is flush with top of bale.

E. Wedge loose straws in any gaps between bales.

3.12 DUST CONTROL

A. Apply appropriate dust control measures on a continuous basis until permanent stabilization measures are in place.

B. Apply on construction routes and other disturbed areas subject to surface dust movement and where off-site damage may occur if dust is not controlled.

C. Avoid creating erosion when using water as a dust controller.

3.13 CLEAN-UP

A. Sediment trapped in erosion control devices shall be regraded into the slopes on the site. Do not flush sediment-laden water into the drainage system.
B. After site restoration is complete and when approved by the Engineer, all temporary erosion control measures shall be completely removed. Immediately shape and permanently stabilize areas affected by the removal process.

C. Silt fence, straw bales, reinforced plastic covering, and any other erosion control devices shall be disposed offsite to locations that are approved by federal, state, and local authorities.

END OF SECTION
SECTION 31 37 00 – RIPRAP

PART 1 - GENERAL

1.1 SCOPE

A. This Section includes the procurement and installation of riprap.

1.2 RELATED SECTIONS

A. Section 31 23 16, EXCAVATION
B. Section 31 23 23.16, TRENCH AND BACKFILL
C. Section 31 05 19.13, GEOTEXTILE FILTER FABRIC

1.3 REFERENCE STANDARDS:

   1. ASTM C97 – Standard Test Methods for Absorption and Bulk Specific Gravity of Dimension Stone
   2. ASTM D4992 – Standard Practice for Evaluation of Rock to Be Used for Erosion Control.

1.4 SUBMITTALS

A. Provide as specified in Section 01 33 00, SUBMITTAL PROCEDURES.
B. Certificates: Certify that products meet or exceed specified requirements.

PART 2 - PRODUCTS

2.1 MATERIALS

A. The riprap shall be hard, sound, and durable. It shall be reasonably free of fines and shall be well graded between the maximum and minimum rock sizes so as to produce a minimum of voids. No riprap shall be placed on the project until it has been accepted by Engineer.
B. The minimum density of stone shall be 130 pounds per cubic foot and the maximum absorption shall be 6 percent.
C. The maximum size shall not be greater than 12-inches in any dimension and approximately 50 percent of the material shall consist of pieces weighing 20 pounds or more. The stones shall be predominantly angular in shape with not more than 25 percent having a length more than 2.5 times its breadth or thickness and none having a length exceeding 3.0 times its breadth or thickness.
D. Geotextile fabric shall be as specified or equal.
E. Contractor shall obtain and submit certification that the proposed rock meets density and absorption requirements specified herein. Testing for certification shall be in accordance with ASTM C97. Certified test results shall be submitted to Engineer prior to the use of the proposed material as riprap.

PART 3 - EXECUTION

3.1 INSTALLATION

A. The riprap layer shall be a minimum of 24-inches thick when placed over the geotextile fabric.

B. When placed on the embankment, the smaller stones shall be well distributed throughout the mass. Hand placing may be required to obtain the results specified above.

C. The areas to be protected with riprap shall be dressed to the lines and grades shown on the Drawings and covered with the geotextile fabric prior to placing the riprap.

D. Riprap graded so that the smaller stones are uniformly distributed throughout the mass shall then be placed, starting at the toe of the slope, with a maximum vertical drop onto the geotextile fabric of 2 feet. In no case shall stones be allowed to roll down the fabric covered slope. Placement of the riprap over the fabric shall proceed so that the upper boundary of the riprap layer is at essentially the same level for the entire length of the fabric.

E. Care shall be taken so that the geotextile fabric is not damaged during riprap installation. Any rips or tears shall be repaired by Contractor, as specified in Section 31 05 19.13, GEOTEXTILE FILTER FABRIC, before proceeding with further riprap installation.

END OF SECTION
SECTION 31 50 00 - EXCAVATION SUPPORT SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes: Work required to install and remove excavation support systems.

B. Related sections:
   1. Section 31 23 23.13 – Fill and Backfill

1.2 SUBMITTALS

A. Shop Drawings:
   1. Excavation support plan.

B. Quality Control Submittals: Movement measurement and data and reduced results indicating movement trends.

1.3 QUALITY ASSURANCE

A. Provide surveys to monitor movements of critical facilities.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 GENERAL

A. Design, provide, and maintain shoring, sheeting, and bracing as necessary and where shown to support the sides of excavations and to prevent detrimental settlement and lateral movement of existing facilities, adjacent property, and completed Work.

B. Minimum areas for sharing, sheeting and bracing are shown on the Drawings. It will be the Contractor's responsibility to determine if areas will require excavation slope retention to protect existing structures and facilities from damage resulting from the Contractor's excavation or excavation methods.

C. The Contractor will also be responsible for providing shoring, sheeting and bracing of excavations as needed for worker safety and as may be required by federal, state, and local regulations.

3.2 EXCAVATION SUPPORT PLAN

A. Prepare excavation support plan addressing following topics:
   1. Details of shoring, bracing, sloping, or other provisions for worker protection of existing structures or facilities.
   2. Design assumptions and calculations.
   3. Methods and sequencing of installing excavation support.
   4. Proposed locations of stockpiled excavated material.
   5. Minimum lateral distance from the crest of slopes for vehicles and stockpiled excavated materials.
3.3 MOVEMENT MONITORING PLAN

A. Prepare movement monitoring plan addressing following topics:
   1. Survey control.
   2. Locations of monitoring points (at least one every 50 feet).
   3. Plots of data trends.
   4. Interval between surveys (not to exceed 5 working days).

B. Movement monitoring shall be done on every existing structure that is adjacent to the Contractor’s excavations.

C. Results of movement monitoring will be delivered for the Engineer at least once a week.

3.4 REMOVAL OF EXCAVATION SUPPORT

A. Do not begin to remove excavation support until it can be removed without damage to existing facilities, completed Work, or adjacent property.

B. Remove excavation support and protection systems when construction has progressed sufficiently to support excavation and earth and hydrostatic pressures. Remove in stages to avoid disturbing underlying soils and rock or damaging structures, pavements, facilities, and utilities. Maintain soil wall support as excavation is backfilled.

C. Fill voids immediately with approved backfill compacted to density specified in Section 31 23 23.13, FILL AND BACKFILL.

END OF SECTION
DIVISION 32

EXTERIOR IMPROVEMENTS
SECTION 32 10 00 - CONCRETE SIDEWALKS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes: Work and materials required to install concrete sidewalk.

B. Related sections:
   1. Section 03 30 00 – Cast-In-Place Concrete.

1.2 REFERENCES

A. The following is a list of standards which may be referenced in this section:
      c. ASTM D994, Standard Specification for Preformed Expansion Joint Filler for Concrete (Bituminous Type)
   2. American Association of State Highway and Transportation Officials (AASHTO): T 99, The Moisture-Density Relations of Soils Using a 5.5 pound (2.5 kg) Rammer and a 12-inch (305 mm) Drop.

1.3 SUBMITTALS

A. Shop Drawings:
   1. Form Material: Information on metal forms, if used, including type, condition, surface finish, and intended function.
   2. Complete data on concrete mix, including aggregate gradations and admixtures in accordance with requirements of ASTM C94.

B. Quality Control Submittals:
   1. Curing Compound: Manufacturer’s Certificate of Compliance and application instructions.
   2. Ready-mix delivery ticket for each truck in accordance with ASTM C94.

PART 2 - PRODUCTS

2.1 EXPANSION JOINT FILLER

A. 1/2-inch thick, preformed asphalt-impregnated, expansion joint material meeting ASTM D994.

2.2 CONCRETE

A. As specified in Section 03 30 00, CAST-IN-PLACE CONCRETE.

B. Maximum Aggregate Size: 1-1/2-inch.

C. Slump: 2 to 4 inches.
2.3 CURING COMPOUND

A. Liquid membrane-forming, clear or translucent, suitable for and meeting ASTM C309, Type 1.

PART 3 - EXECUTION

3.1 FORMWORK

A. Lumber Materials:
   1. 2-inch dressed dimension lumber, or metal of equal strength, straight, free from defects that would impair appearance or structural quality of completed sidewalk.
   2. 1-inch dressed lumber or plywood may be used where short-radius forms are required.

B. Metals: Steel in new undamaged condition.

C. Setting Forms:
   1. Construct forms to shape, lines, grades, and dimensions.
   2. Stake securely in place.

D. Bracing:
   1. Brace forms to prevent change of shape or movement resulting from placement.
   2. Construct short-radius curved forms to exact radius.

E. Tolerances:
   1. Do not vary tops of forms from gradeline more than 1/8-inch when checked with 10-foot straightedge.
   2. Do not vary alignment of straight sections more than 1/8-inch in 10 feet.

3.2 PLACING CONCRETE

A. Prior to placing concrete, remove water from excavation and debris and foreign material from forms.

B. Place concrete as soon as possible, and within 1-1/2 hours after adding cement to mix without segregation or loss of ingredients, and without splashing.

C. Place, process, finish, and cure concrete in accordance with applicable requirements of ACI 304, and this section. Wherever requirements differ, the more stringent shall govern.

D. To compact, vibrate until concrete becomes uniformly plastic.

3.3 SIDEWALK CONSTRUCTION

A. Thickness:
   1. 4 inches in walk areas.
   2. 6 inches in driveway areas.

B. Connection to Existing Sidewalk:
   1. Remove old concrete back to an existing contraction joint.
   2. Clean the surface.
   3. Apply a neat cement paste immediately prior to placing new sidewalk.

C. Expansion Joints: Place at building corners and changes in sidewalk width around posts, poles, or other objects penetrating sidewalk. Install expansion joint filler at each joint.
D. Contraction Joints:
   1. Provide transversely to walks at locations opposite contraction joints in curb.
   3. Construct straight and at right angles to surface of walk.

E. Finish:
   1. Broom surface with fine-hair broom at right angles to length of walk and tool at edges, joints, and markings.
   2. Mark walks transversely at 5-foot intervals with jointing tool; finish edges with rounded steel edging tool.
   3. Apply curing compound to exposed surfaces upon completion of finishing.
   4. Protect sidewalk from damage and allow to cure for at least 7 days.

3.4 SLAB CONSTRUCTION ON GRADE

A. Thickness: Four inches or as shown.

B. Contraction Joints:
   1. As shown on Drawings.
   3. Construct straight and at right angles to surface of slab.

C. Finish:
   1. Broom surface with fine-hair broom and tool of edges, joints, and markings.
   2. Apply curing compound to exposed surfaces upon completion of finishing.
   3. Protect sidewalk from damage and allow to cure for at least 7 days.

END OF SECTION
SECTION 32 11 00 - BASE COURSE

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes: Work and materials required to install base course.

B. Related sections:
   1. Section 31 22 13 – Subgrade Preparation.

1.2 REFERENCES

A. The following is a list of standards which may be referenced in this section:

   1. American Association of State Highway and Transportation Officials (AASHTO):
      b. T 90, Determining the Plastic Limit and Plasticity Index of Soils.
         Size Course Aggregate by Abrasion and Impact in the Los Angeles Machine.
      d. T 99, Standard Methods of Test for the Moisture-Density Relations of Soils Using a
         5.5 pound (2.5 kg) Rammer and a 12-inch (305 mm) Drop.
      e. T 180, Standard Methods of Test for the Moisture-Density Relations of Soils Using
         a 10 pound (4.54 kg) Rammer and an 18-inch (457 mm) Drop.
      f. T 191, Standard Method of Test for Density of Soil In-Place by the Sand-Cone
         Method.

1.3 DEFINITIONS

A. Completed Course: Compacted, unyielding, free from irregularities, with smooth, tight, even
   surface, true to grade, line, and cross-section.

B. Completed Lift: Compacted with uniform surface reasonably true to cross-section.

C. Standard Specification: The latest edition, including supplements of the Alabama Department of
   Transportation (ALDOT).

1.4 SUBMITTALS

A. Quality Control Submittals:

   1. Certified Test Results on Source Materials: Submit copies from commercial testing
      laboratory 20 days prior to delivery of materials to project.
   2. Certified Results of In-Place Density Tests from independent testing agency.

PART 2 - PRODUCTS

2.1 BASE COURSE ROCK

A. As specified for Type B in Section 825 of the Standard Specifications Alabama Department of
   Transportation Standard Specifications.
2.2 SOURCE QUALITY CONTROL

A. Contractor: tests necessary to locate acceptable source of materials meeting specified requirements.

B. Final approval of aggregate material will be based on materials' test results on installed materials.

C. Should separation of course from fine materials occur during processing or stockpiling, immediately change methods of handling materials to correct uniformity in grading.

PART 3 - EXECUTION

3.1 PREPARATION

A. As specified in Section 31 22 13, SUBGRADE PREPARATION.

B. Obtain Engineer’s acceptance of subgrade before placement of base course rock.

C. Do not place base materials in snow or on soft, muddy, or frozen subgrade.

3.2 EQUIPMENT

A. In accordance with application sections of the Standard Specifications.

B. Compaction Equipment: Adequate in design and number to provide compaction and obtain the specified density for each layer.

3.3 HAULING AND SPREADING

A. Hauling Materials:
   1. Do not haul over surfacing in process of construction.
   2. Loads: Of uniform capacity.
   3. Measure capacity of truck to determine vehicle load and quantity.
   4. Maintain consistent gradation of material delivered; loads of widely varying gradations will be cause for rejection.

B. Spreading Materials:
   1. Distribute material to provide required density, depth, grade and dimensions with allowance for subsequent lifts.
   2. Produce even distribution of material upon roadway without segregation.
   3. Should segregation of coarse from fine materials occur during placing, immediately change methods of handling materials to correct uniformity in grading.

3.4 CONSTRUCTION OF COURSES

A. General: Complete each lift in advance of laying succeeding lift to provide required results and adequate inspection.

B. Base Course:
   1. Maximum Completed Lift Thickness: 6 inches.
   2. Completed Course Total Thickness: As shown.
3. Spread lift on preceding course to required cross-section.
4. Lightly blade and roll surface until thoroughly compacted.
5. Add keystone to achieve compaction and as required when aggregate does not compact readily due to lack of fines or natural cementing properties, as follows:
   a. Use base 1/4-minus crushed aggregate material as keystone.
   b. Spread evenly on top of crushed base course, using spreader boxes or chip spreaders.
   c. Roll surface until keystone is worked into interstices of crushed base course without excessive displacement.
   d. Continue operation until course has become thoroughly keyed, compacted, and will not creep or move under roller.
6. Blade or broom surface to maintain true line, grade, and cross-section.

3.5 ROLLING AND COMPACTION

   A. Blade or otherwise work existing surface as necessary to achieve a smooth and thoroughly compacted surface.
   B. Commence compaction of each layer of base after spreading operations and continue until density of 100 percent of maximum density has been achieved as determined by AASHTO T 99.
   C. Commence rolling at outer edges of surfacing and continue toward center; do not roll center of road first.
   D. Apply water as needed to obtain densities.
   E. Place and compact each lift to required density before succeeding lift is placed.
   F. Bind up preceding course before placing leveling course. Remove floating or loose stone from surface.
   G. Blade or otherwise work surfacing as necessary to maintain grade and cross-section at all times, and to keep surface smooth and thoroughly compacted.
   H. Surface Defects: Remedy surface defects by loosening and rerolling entire area, including surrounding surface, until thoroughly compacted.
      1. Finished Surface: True to grade and crown before proceeding with surfacing.

3.6 SURFACE TOLERANCES

   A. Finished Surface of Base Course: Within plus or minus 0.04-foot of grade shown at any individual point.
   B. Overall Average: Within plus or minus 0.01-foot from crown and grade specified.

3.7 FIELD QUALITY CONTROL

   A. In-Place Density Tests:
      1. Construct base course so areas shall be ready for testing.
      2. Allow reasonable length of time for testing laboratory to perform tests and obtain results during normal working hours.
3. Show proof that areas meet specified requirements before identifying density test locations.
4. Perform a minimum of 2 tests on completed course per 200 cubic yards of material placed in accordance with T 191, or T 238 at locations acceptable to Engineer.

B. Cleaning

1. Remove excess material; clean stockpile areas of aggregate.

END OF SECTION
SECTION 32 12 16 - ASPHALT CONCRETE PAVEMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes: Providing and placing Asphalt Concrete Hot Mix (ACHM).

B. Related sections:
   1. Section 31 22 13 – Subgrade Preparation.

1.2 REFERENCE STANDARDS

A. The following is a list of standards which may be referenced in this section:

1.3 DEFINITIONS

A. Combined Aggregate: All mineral constituents of an asphalt concrete mix, including mineral filler and separately sized aggregates.


1.4 SUBMITTALS

A. Shop Drawings: Job-mix formula for pavements.

B. Quality Control Submittals:
   1. Statement of qualification for independent testing laboratory.
   2. Test Results:
      a. For Each Trial Batch of the Mix Design:
         1). Aggregate gradation.
         2). Asphalt content.
         3). Stability number.
         4). Percent air voids.
         5). Percent voids in mineral aggregate.
         6). Density.
         7). Retained strength.
      b. Asphalt cement for binder.
      c. Field density.
   3. Manufacturer’s Certificate of Compliance for the following materials:
      a. Aggregate: Gradation.
      b. Asphalt for Binder: Type and grade.
      c. Prime Coat: Type and grade of asphalt.
d. Tack Coat: Type and grade of asphalt.
e. Additives.
f. Mix: Conforms to job-mix formula.

1.5 QUALITY ASSURANCE
A. Manufacturer Qualifications: A paving-mix manufacturer registered with and approved by the Alabama Department of Transportation.
B. Independent Testing laboratory: In accordance with ASTM D3666 for testing indicated.

1.6 ENVIRONMENTAL REQUIREMENTS
A. Asphalt Concrete:
   1. Place asphalt concrete only when surface is dry, when atmospheric temperature in the shade is 40 degrees F and rising, or above 50 degrees F if falling.
   2. Do not place asphalt concrete when weather is foggy or rainy nor when base on which material is to be placed is in wet or frozen condition.
B. Prime Coat:
   1. Do not apply prime coat when atmospheric temperature is below 60 degrees F.
   2. Apply prime coat only when base course is dry or contains moisture not in excess of that which will permit uniform distribution and desired penetration.
C. Measure temperature in shaded areas away from heat sources or wet surfaces.

PART 2 - PRODUCTS
2.1 AGGREGATE
A. As specified in Section 424 of the Alabama Department of Transportation Standard Specifications for Highway Construction; however, reclaimed material will not be acceptable.

2.2 MINERAL FILLER
A. As specified in Section 805 of the Alabama Department of Transportation Standard Specifications for Highway Construction.

2.3 PRIME COAT
A. Cutback asphalt, conforming to Section 401 of the Alabama Department of Transportation Standard Specifications for Highway Construction.

2.4 TACK COAT
A. Emulsified asphalt, conforming to Section 405 of the Alabama Department of Transportation Standard Specifications for Highway Construction.

2.5 ASPHALT CONCRETE MIXTURE
A. As follows based on Section 424 of the Alabama Department of Transportation Standard Specifications for Highway Construction:
   1. Binder Course: SP Bituminous Concrete, 12.5 mm
   2. Surface Course: SP Bituminous Concrete, 12.5 mm
   3. Thickness: As specified on Drawings.
B. Update mix as necessary to meet Project conditions and geographical area where Project is located.

2.6 SOURCE QUALITY CONTROL

A. Tests: Furnish services of independent testing laboratory to conduct tests.

1. Job-Mix Formula for Pavements:
   a. Define gradation for each of the aggregate constituent used in mixture and establish exact proportion of each constituent to produce a gradation of aggregate within specified limits.
   b. Bulk specific gravity for each aggregate constituent.
   c. Measured maximum specific gravity of mix at optimum asphalt content determined in accordance with ASTM D2041.
   d. Properties as stated in Alabama Department of Transportation Standard Specifications for Highway Construction for at least four different asphalt contents other than optimum, two below optimum, and two above optimum.
   e. Percent of asphalt lost due to absorption by aggregate.
   f. After each job-mix formula is established, the combined aggregate grading of respective mixture furnished to the Project shall meet tolerances specified in the Alabama Department of Transportation Standard Specifications for Highway Construction.

PART 3 - EXECUTION

3.1 GENERAL

A. Application Equipment: In accordance with Section 410 of Standard Specifications.

B. Roadways: Construct to lines, grades, and cross-sections shown.

C. Traffic Control:
   1. Minimize inconvenience to traffic but keep vehicles off freshly treated or paved surfaces to avoid pickup and tracking of asphalt. Maintain at least one-way traffic at all times.
   2. Contractor shall be solely responsible for traffic control and for meeting all federal, state, and local requirements for such.

3.2 CONTROL OF LINE AND GRADE

A. Provide and maintain intermediate control of the underlying base to meet finish surface grades and minimum thickness.

3.3 SURFACE PREPARATION FOR ASPHALT OVER EXISTING GRAVEL ROAD

A. Blade or otherwise work existing surface as necessary to achieve a smooth and thoroughly compacted surface.

B. Surface Depressions: Fill with base course, and thoroughly compact.

3.4 TACK COAT

A. Do not apply more tack coat than necessary for the day's paving operation.

B. Application: Apply tack coat uniformly to clean dry surfaces. Avoid overlapping of applications. Touch up missed or lightly coated surfaces and remove excess tack coat.
C. Application Rate: Minimum 0.05-gallon to maximum 0.15-gallon of asphalt (residual if diluted emulsified asphalt) per square yard of surface area. Apply at rate, within range specified, sufficient to assure good bonding, but not too heavy that surplus asphalt flushes into asphalt concrete being placed.

3.5 ASPHALT CONCRETE PAVEMENT PLACEMENT

A. Lay asphalt concrete over prepared base in a single lift to a total compacted thickness as shown on Plans.

B. Collect and dispose of segregated aggregate from raking process. Do not scatter material over finished surface.

3.6 CONNECTIONS WITH EXISTING FACILITIES

A. Where asphalt concrete pavement connects to an existing roadway surface, bridge, railway crossing, or other facility, modify existing roadway profile to produce a smooth riding connection to existing facility.

B. Modifying Existing Surfaces: Sawcut existing paved surfaces to provide meet lines and surfaces. Allow for sufficient depth of removal to reinstall a minimum thickness of 1-inch of asphalt concrete.
   1. Meet Lines: Lines straight and edges vertical.
   2. Edges of Meet Line Cuts: Paint with tack coat prior to placing pavement.
   3. Sealing Meet Line: After placement of pavement, by painting with liquid asphalt or emulsified asphalt, cover immediately with clean, dry sand.

C. Paint edges of contact surfaces (curbs, manhole frames), before laying pavement, with tack coat or paving asphalt cement to provide watertight joints. Do not stain adjacent surfaces not intended to be coated.

3.7 JOINTS

A. Offset edge of each layer a minimum of 6 inches so joints shall not be directly over those in underlying layer.

B. Offset longitudinal joints in roadway pavements, so longitudinal joints in wearing layer coincide with pavement centerlines and lane divider lines.

C. Form transverse joints by cutting back on previous day’s run to expose full vertical depth of layer.

3.8 PATCHING

A. Patch Thickness: 3 inches or thickness of adjacent asphalt concrete, whichever is greater.

B. Preparation:
   1. Remove damaged, broken, or unsound asphalt concrete adjacent to patches. Trim to straight lines exposing smooth, sound, vertical edges.
   2. Prepare patch as specified in Section 31 22 13, SUBGRADE PREPARATION.

C. Construction:
   1. Place asphalt concrete mix across full width of patch in layers of equal thickness.
   2. Spread and grade asphalt concrete with hand tools or mechanical spreader, depending on size of area to be patched.
   3. Finished surface of patch shall be flush with adjacent surface and match grade, slope, and crown of adjacent surface.
D. Compaction:
   1. Roll patches with power rollers capable of providing compression of 200 to 300 pounds per linear inch. Use hand tampers where rolling is impractical.
   2. Begin rolling top course at edge of patches, lapping adjacent asphalt surface at least 1/2 the roller width. Progress toward center of patch overlapping each preceding track by at least 1/2 the width of roller. Make sufficient passes over entire area to remove roller marks and to produce desired finished surface.

E. Surface Smoothness of Replaced Pavement: New pavement shall not deviate more than plus 1/4-inch or minus 0 inches when a straightedge is laid across patched area between edges of new pavement and surface of old surfacing.

3.9 COMPAC TION

A. Roll until roller marks are eliminated and a density of 92 percent of measured maximum density determined in accordance with ASTM D2041 and ASTM D2950 is obtained.

3.10 JOINT COMPACTION

A. Place top or wearing layer as continuously as possible.

B. Pass roller over unprotected end of freshly laid mixture only when laying of layer is discontinued long enough to permit mixture to become chilled.

C. Cut back previously compacted mixture when Work is resumed to produce a slightly beveled edge for full thickness of layer.

D. Cut away waste material and lay new mix against fresh cut.

3.11 TOLERANCES

A. Conduct measurements for conformity with crown and grade immediately after initial compression. Correct variations immediately by removal or addition of materials and by continuous rolling.

B. Tolerance Measurements:
   1. Completed Surface of Top or Wearing Layer: Uniform texture, smooth, and uniform to crown and grade.
   2. Completed surface shall not vary more than 1/8-inch from lower edge of 10-foot straightedge placed on surface parallel to centerline.
   3. Transverse slope of completed surface shall not vary more than 1/4-inch in 10 feet from the rate of transverse slope shown.
   4. Finished grade shall not vary more than 0.02 feet.

C. Correct deviations in excess of specified tolerances by addition of asphalt concrete mixture to low places or removal of material from high places.

D. Wearing surface may be removed and replaced to achieve a satisfactory finish surface, if surface of completed pavement deviates by more than twice the specified tolerances.

3.12 FIELD QUALITY CONTROL

A. General: Provide services of independent testing laboratory to conduct tests.

END OF SECTION
SECTION 32 31 13 - CHAIN LINK FENCES AND GATES

PART 1 - GENERAL

1.1 REFERENCES

A. The following is a list of standards which may be referenced in this section:

   e. ASTM A824, Standard Specification for Metallic-Coated Steel Marcelled Tension Wire for Use with Chain Link Fence.
   h. ASTM C143, Standard Test Method for Slump of Hydraulic-Cement Concrete.
   i. ASTM C387, Standard Specifications for Packaged, Dry, Combined Materials for Concrete and High Strength Mortar.
   j. ASTM F552, Standard Terminology Relating to Chain Link Fencing.
   k. ASTM F567, Standard Practice for Installation of Chain-Link Fence.
   m. ASTM F668, Standard Specification for Polyvinyl Chloride (PVC) and Other Organic Polymer-Coated Steel Chain-Link Fence Fabric.
   o. ASTM F1043, Standard Specification for Strength and Protective Coatings on Steel Industrial Chain Link Fence Framework.
   q. ASTM F1183, Standard Specifications for Aluminum Alloy Chain Link Fence Fabric.
   r. ASTM F1184, Standard Specifications for Industrial and Commercial Horizontal Slide Gates.

2. Institute of Electrical and Electronic Engineers (IEEE), Inc.: National Electrical Safety Code.
3. National Electrical Manufacturers Association (NEMA): 250, Enclosures for Electrical Equipment (1,000 volts max.).

1.2 DEFINITIONS

A. Terms as defined in ASTM.

1.3 SUBMITTALS

A. Shop Drawings:
   1. Detailed information and specifications for materials, finishes, and dimensions.
   2. Card access system serial communication interface card code message format.

B. Samples: Approximately 6 inches square, or 6 inches long of posts, rails, braces, fabric, wire, ties, and fittings.
C. Quality Control Submittals:
   1. Manufacturer's recommended installation instructions.
   2. Evidence of Supplier and installer qualifications.

1.4 SCHEDULING AND SEQUENCING
A. Complete necessary site preparation and grading before installing chain link fence and gates.

PART 2 - PRODUCTS

2.1 GENERAL
A. Match style, finish, and color of each fence component with that of other fence components.

2.2 CHAIN LINK FENCE FABRIC
A. Galvanized fabric conforming to ASTM, Class 1; galvanized after weaving.
B. Height: 72 inches, unless otherwise shown.
C. Wire Gauge: No. 9, barewire.
D. Pattern: 2-inch diamond-mesh.
E. Diamond Count: Manufacturer's standard and consistent for fabric furnished of same height.
F. Loops of Knuckled Selvages: Closed or nearly closed with space not exceeding diameter of wire.
G. Wires of Twisted Selvages:
   1. Twisted in a closed helix three full turns.
   2. Cut at an angle to provide sharp barbs that extend minimum 1/4-inch beyond twist.

2.3 POSTS
A. General:
   1. Strength and Stiffness Requirements: ASTM F1043, Light Industrial Fence, except as modified in this section.
   3. Roll-Formed Steel Shapes: from ASTM A1018, Grade 45, Steel.
   4. Lengths: Manufacturer's standard with allowance for minimum embedment below finished grade of 22 inches plus 3 inches for each 1 foot of fence height greater than 4 feet.
   5. Protective Coatings:
      a. Zinc Coating: ASTM F1043, Type A external and internal coating.
B. Line Posts:
   1. Steel Pipe:
      b. Weight: 3.65 pounds per foot.
C. End, Corner, Angle, and Pull Posts:
   1. Steel Pipe:
      a. Outside Diameter: 2.875-inch.
      b. Weight: 5.79 pounds per foot.
D. Posts for Swing Gates:
   1. ASTM F900.
      a. Outside Dimensions: 4-inch diameter.
      b. Weight: 6.56 pounds per foot.

2.4 TOP RAILS AND BRACE RAILS
   1. Galvanized steel pipe.
   2. Protective Coatings: As specified for posts.
   4. Steel Pipe:
      a. ASTM F1083.
      b. Outside Diameter: 1.66-inch.
      c. Weight: 2.27 pounds per foot.

2.5 FENCE FITTINGS
   A. General: In conformance with ASTM F626, except as modified by this article.
   B. Post and Line Caps: Designed to accommodate passage of top rail through cap, where top rail required.
   C. Tension and Brace Bands: No exceptions to ASTM.
   D. Tension Bars:
      1. One-piece, no exceptions to ASTM F626.
      2. Equal in length to full height of fabric.
   E. Truss Rod Assembly: 3/8-inch diameter.
   F. Barb Arms: 45-degree arms for supporting three strands of barbed wire.

2.6 TENSION WIRE
   A. Zinc-coated steel marcelled tension wire conforming to ASTM A824, Type II, Class 2.

2.7 BARBED WIRE
   A. Zinc-Coated Barbed Wire: ASTM A121, Chain Link Fence Grade:
      1. Line Wire: Two strands of No. 12-112 gauge.
      2. Barbs:
         a. Number of Points: Four.
         b. Length: 318-inch minimum.
         c. Shape: Round.
         d. Diameter: No. 14-gauge.
         e. Spacing: 5 inches.

2.8 GATES
   A. General:
      1. Gate Operation: Opened and closed easily by one person.
      3. Chain Link Fabric: Attached securely to gate frame at intervals not exceeding 15 inches.
   B. Swing Gates: ASTM F900.
1. **Hinges:**
   a. Furnished with large bearing surfaces for clamping in position.
   b. Designed to swing either 180 degrees outward, 180 degrees inward, or 90 degrees in or out, as shown, and not twist or turn under action of gate.
2. **Latches:** Plunger bar arranged to engage stop, except single gates of openings less than 10 feet wide may each have forked latch.
3. **Gate Stops:** Mushroom type or flush plate with anchors, suitable for setting in concrete.
4. **Locking Device and Padlock Eyes:** Integral part of latch, requiring one padlock for locking both gate leaves of double gates.
5. **Hold-Open Keepers:** Designed to automatically engage gate leaf and hold it in open position until manually released.

2.9 **CONCRETE**

A. Provide as specified in Section 03 30 00, CAST-IN-PLACE CONCRETE.

2.10 **REPAIR AND SALVAGE OF EXISTING FENCE**

A. **Non-Salvageable or Non-Reusable Parts:**
   1. Fence posts.
   2. Gate posts.
   3. End, corner angle, and pull posts.
   4. Tension and brace bands.
   5. Tension wire.

B. **Salvageable or Reusable Items:**
   1. Fence fabric.
   2. Post caps.
   3. Top rails and brace rails.
   4. Truss rod assemblies.
   5. Barb arms.

C. All items noted as salvageable shall not be bent, twisted, dented, or damaged in any way. Any such items will not be considered for reuse.

D. All items not considered for salvage or reuse shall be disposed of offsite at the Contractor's expense. See Section 02 41 00, DEMOLITION.

**PART 3 - EXECUTION**

3.1 **GENERAL**

A. Install chain link fences and gates in accordance with ASTM F567, except as modified in this section, and in accordance with fence manufacturer's recommendations, as approved by Engineer. Erect fencing in straight lines between angle points.

B. Provide all necessary hardware for a complete fence and gate installation.

3.2 **PREPARATION**

A. Establish locations of fence lines, gates, and terminal posts.
3.3 POST SETTING
   A. Driven posts are not acceptable.
   B. Post Hole Depth:
      1. Minimum 3 feet below finished grade.
      2. 2 inches deeper than post embedment depth below finish grade.
   C. Backfill post holes with concrete to 2 inches above finished grade.
   D. Before concrete sets, crown and finish top of concrete to readily shed water.

3.4 BRACING
   A. Brace gate and corner posts diagonally to adjacent line posts to ensure stability.

3.5 TOP RAILS
   A. Install top rail sleeves with springs at 105 feet maximum spacing to permit expansion in rail.

3.6 CHAIN LINK FABRIC
   A. Do not install fabric until concrete has cured minimum 7 days.
   B. Install fabric with twisted and barbed selvage at top.

3.7 BARBED WIRE
   A. Install three strands of barbed wire on brackets, tighten, and secure at each bracket.

3.8 GATES
   A. Hang gates and adjust hardware so gates operate satisfactorily from open or closed position.
   B. Set gate stops in concrete to engage center drop rod or plunger bar.

3.9 FIELD QUALITY CONTROL
   A. Gate Tests: Prior to acceptance of installed gates and gate operator systems, demonstrate proper operation of gates under each possible open and close condition specified.

3.10 REUSE OF EXISTING FENCE MATERIAL
   A. Existing fence material shall be installed on new posts using new tension bars, brace bands, and tension wire.
   B. Existing fence fabric shall not be spliced to new fence fabric at mid-length between posts where the existing fence fabric ends. A pull post shall be installed with new brace bands, tension bands, and tension wire. Provide a knuckled selvage at the cut portion of the fence as shown on the Drawings.

END OF SECTION
SECTION 32 91 19 - SODDING, SEEDING, FERTILIZING, AND MULCHING

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes:
   1. Sodding.
   2. Fertilizer.
   3. Mulch.
   4. Seed.
   5. Preparation.

B. Related Sections:
   1. Section 31 23 16 – Excavation
   2. Section 31 23 23.13 – Fill and Backfill

C. Alternate Methods and Products:
   1. Alternate methods from those specified will be considered for use, provided that in the
      Engineer's opinion the end product will be equal to or exceed that which would result from
      the specified methods and products.

1.2 DEFINITIONS

A. Weeds:
   1. Includes Dandelion, Jimsonweed, Quackgrass, Horsetail, Morning Glory, Rush Grass,
      Mustard, Lambsquarter, Chickweed, Cress, Crabgrass, Canadian Thistle, Nutgrass, Poison
      Oak, Blackberry, Tansy Ragwort, Bermuda Grass, Johnson Grass, Poison Ivy, Nut Sedge,
      Nimble Will, Bindweed, Bent Grass, Wold Garlic, Perennial Sorrel, and Brome Grass.

1.3 REGULATORY REQUIREMENTS

A. Comply with regulatory agencies for fertilizer and herbicide composition.

1.4 QUALITY ASSURANCE

A. Provide seed mixture in containers showing percentage of seed mix, year of production, net
   weight, date of packaging, and location of packaging.

1.5 MAINTENANCE DATA

A. Submit maintenance data for continuing Owner maintenance.

B. Include maintenance instruction, cutting method, maximum grass height, types, application
   frequency, and recommended coverage of fertilizer.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver grass seed mixture in sealed containers. Seed in damaged packaging is not acceptable.

B. Deliver fertilizer in water proof bags showing weight, chemical analysis, and name of
   manufacturer.
PART 2 - PRODUCTS

2.1 AGRICULTURAL LIMESTONE

A. Shall be agricultural limestone with not less than 90 percent passing the No. 4 sieve and containing not less than 40 percent calcium carbonate equivalent. Lime shall be applied at the rate recommended by soil test.

2.2 FERTILIZER

A. Shall be a standard commercial product which when applied at the proper rate will supply the equivalent quantity of total nitrogen, available phosphoric acid and soluble potash specified. Fertilizer shall be delivered to the site in bags or other suitable containers, each fully labeled, conforming to applicable state fertilizer laws, and bearing the name, trade name or trademark, and warranty of the producer.

B. Requirements per acre:
   1. Six hundred pounds of 17-17-17 grade fertilizer or equivalent.

2.3 MULCH

A. Shall be vegetative mulch consisting of cereal straw from stalks of oats, rye, wheat or barley. Straw shall be free of prohibited weed seeds as stated in State Seed Law and shall be relatively free of all other noxious and undesirable seeds. Straw shall be clean and bright, relatively free of foreign material and be dry enough to be spread properly.

2.4 SEED

A. Seed shall be a mixture with the specified minimum purity and germination requirements, as follows:

<table>
<thead>
<tr>
<th>Seed Type</th>
<th>% Mix (By Weight)</th>
<th>Purity (%)</th>
<th>Germination (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kentucky K-31 Fescue</td>
<td>52</td>
<td>97</td>
<td>85</td>
</tr>
<tr>
<td>Creeping Red Fescue</td>
<td>18</td>
<td>85</td>
<td>80</td>
</tr>
<tr>
<td>Rye Grass</td>
<td>8</td>
<td>98</td>
<td>85</td>
</tr>
<tr>
<td>Rye Grain</td>
<td>22</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

B. Variation in the above mix to suit local conditions or time of year may be required.

C. Seed shall be labeled in accordance with USDA regulations. Care shall be taken during transportation to avoid segregation of seed mixtures.

D. Seed shall be sown at a rate of 217 pounds of seed mix per acre for drill seeding. Seed mixture shall be thoroughly mixed prior to application.

2.5 SODDING

A. Sodding shall consist of furnishing, and placing sod at all locations shown on the Plans, where directed by the Engineer, and in conformity with these Specifications. Sod shall consist of a live, dense, well-rooted growth of permanent grasses, free of weeds and weedy grasses. All sod shall be cleanly cut in strips having a reasonably uniform thickness of not less than 1 inch, a reasonable uniform width of not less than 8 inches, and a length not less than 12 inches. Sod shall be Kentucky 31 Fescue, Bluegrass, or Bermuda grass. It shall be the obligation of the Contractor to secure a satisfactory growth of grass before final acceptance of the project.
PART 3 - EXECUTION

3.1 GENERAL

A. The application of fertilizer, seed, and mulch shall follow each other in successive sequence as closely as possible. Seeding shall be accomplished in the first of the following two periods after completion of earthwork:
   1. February 15 to May 1
   2. September 1 to October 1

B. Seeding outside the specified seeding periods may be permitted at the Engineer's option, provided the Contractor is willing to make appropriate modifications to his seeding operations, and will guarantee the crop.

3.2 INSPECTION

A. Contractor must request that Engineer inspect site grading, clean-up and surface preparation to determine if site is ready for the seeding, fertilizing and mulching operations.

B. Upon Engineer's approval operations may begin.

3.3 SURFACE PREPARATION

A. Immediately in advance of fertilizing, the surface to be seeded shall be repaired, if necessary, to eliminate all damage from erosion or construction operations. The surface shall then be loosened and thoroughly pulverized by discing, harrowing and raking or other approved methods, to such an extent that it is free from sod, stones, clods, or roots. All growth of vegetation that will seriously interfere with planting operations shall be removed and disposed of as directed. The final surface shall be smooth and uniform, and left in such a condition as to prevent formation of low places and pockets.

3.4 FERTILIZING

A. Fertilizer and lime shall be dressed evenly over the areas to be seeded using approved mechanical type spreading equipment.

B. Fertilizer and lime after spreading shall be immediately incorporated into the soil to a depth of approximately 2 inches, by chisel, spike tooth harrow, or other approved methods.

3.5 SEEDING METHODS

A. General methods:
   1. The Contractor shall employ a satisfactory method of sowing by use of either approved mechanical hand seeders or mechanical power-driven drills. When delays in operation carry the work beyond the specified planting seasons, or when conditions are such that by reason of drought, high winds, excessive moisture, or other factors, satisfactory results are not likely to be obtained, seeding shall stop. It will be resumed only where the desired results are probable or when approved alternate procedures have been adopted.

B. Broadcast seeding:
   1. When broadcast seeding is utilized, the seed shall be uniformly broadcast by mechanical hand seeder, in two directions at right-angles to each other and at 1/2 of the specified rate per acre in each direction. After the seed is broadcast it shall be covered by an approved method to a depth of 1/3 inch to 3/4 inch. Broadcast seeding shall not be done in windy weather.
C. Drill seeding:
   1. When drilling is utilized, it shall be done with approved equipment best suited to perform the work under prevailing conditions. The seed shall be uniformly drilled to a depth of one-third (1/3) inch to three-fourths (3/4) inch at the rate per acre specified. Drill seeding may be required in windy weather.

D. Prior to start of seeding, the Contractor shall demonstrate that the application of seed is being made at the specified rate. A final check of the total quantity of seed used shall be made against the area seeded. If the check shows that the Contractor has not applied seed at the specified rate, he shall uniformly distribute seed at a rate calculated to meet the shortage.

E. The Contractor shall maintain the seeded areas until all fertilizing, seeding and mulching is complete and the work accepted by the Engineer. Areas damaged from the Contractor's own operations shall be repaired at his expense. After acceptance of the work the Contractor will not be held responsible for erosion due to weather, or conditions not due to the Contractor's own operations or negligence. The Contractor is not required to guarantee a crop, if seeding is done during the specified seeding periods.

3.6 MULCHING

A. Immediately after seeding, the Contractor shall apply vegetative mulch at a rate between 1-1/2 and 2-1/2 tons per acre to all seeded areas. Quantity of mulch shall be adjusted within the above limits, as directed by the Engineer, to the particular area or slope being mulched. Total application of mulch for the project shall average approximately 2 tons per acre. Mulch shall be applied by mechanical mulch spreaders equipped to eject by means of a constant air stream controlled quantities of the vegetative mulch.

B. Mulch shall be embedded by a disc type roller having flat serrated discs spaced not more than 10 inches apart, with cleaning scrapers for each disc.

C. Where indicated, or in areas of the project where soil conditions are not suitable for satisfactory crimping, asphalt emulsion shall be applied with the mulching operation. The normal rate of application shall be 100 gallons per ton of straw; however, this rate may be varied as directed by the Engineer to suit the particular area or slope conditions.

D. All mulch shall be distributed evenly over the areas to be mulched within 24 hours after the seeding operation. Following the mulching operation, suitable precautions shall be taken to prohibit traffic over mulched areas. Displaced mulch shall be replaced immediately, including repair of the underlying seed bed, if damaged as well.

3.7 MAINTENANCE

A. The Contractor shall maintain all seeded areas until the grass is properly established (not less than 90 days) until satisfactory development. Maintenance shall be continued until final acceptance of the work.

B. Maintenance of seeded areas shall include protecting, watering, mowing, fertilizing, and such other work as may be necessary to establish a permanent lawn. The Contractor shall reseed those seeded areas in which a satisfactory growth is not obtained, and shall refill any areas which become eroded prior to final acceptance of the work.

C. Paved areas shall be kept clean while maintenance operations are in progress.
3.8 REPLACEMENT

A. The Contractor shall replace all trees, shrubs, and flowers damaged by construction activities in the areas designated on the construction plans. The replacement trees and shrubs shall be equal in size to the damaged or removed specimen.

END OF SECTION
DIVISION 33

UTILITIES
SECTION 33 13 00 - DISINFECTION OF WATER SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes: Work, material, and procedures for disinfection of installed potable water lines.

B. Related sections:
   1. Section 01 33 00 – Submittal Procedures.

1.2 REFERENCES

A. The following is a list of standards which may be referenced in this section:
   1. American Water Works Association (AWWA):
      a. AWWA B300, Hypochlorites.
      b. AWWA B301, Liquid Chlorine.
      c. AWWA B303, Sodium Chlorite.
      d. AWWA C651, Disinfecting Water Mains.
      e. AWWA C652, Disinfection of Water-Storage Facilities.
      f. AWWA C653, Disinfection of Water Treatment Plants.
      g. AWWA C654, Disinfection of Wells.

1.3 QUALITY CONTROL SUBMITTALS

A. Procedures and plans for disinfection and testing.

B. Type of disinfecting solution and method of preparation.

1.4 SEQUENCING AND SCHEDULING

A. Commence disinfection after completion of following:
   1. Completion and acceptance of internal painting of system(s).
   2. Hydrostatic and pneumatic testing, pressure testing, functional and performance testing and acceptance of pipelines, pumping systems, structures, and equipment.

PART 2 - PRODUCTS

2.1 WATER FOR DISINFECTION AND TESTING

A. Clean, uncontaminated, and potable.

B. Owner will supply potable quality water, Contractor shall convey in disinfected pipelines or containers.

2.2 CONTRACTOR’S EQUIPMENT

A. Furnish chemicals and equipment, such as pumps and hoses, to accomplish disinfection.

2.3 MIXING DISINFECTANT.

A. Prepare solution by mixing any of following as described below. The purpose of the stock solution is to facilitate mixing and dilution to ensure a uniform disinfecting solution. The Contractor will not be required to mix a stock solution if a liquid chlorine gas feed system that
can accurately feed a desired amount of chlorine to mix a final (dilute) disinfecting solution is used.

1. Liquid chlorine gas conforming to AWWA B301 and water mixture.
2. Dry chlorine gas conforming to AWWA B301.
3. Calcium hypochlorite conforming to AWWA B300 or sodium hypochlorite conforming to AWWA B303 powder or liquid and water mixture.

B. Feed dry chlorine gas through devices to regulate the rate of flow and ensure uniform diffusion of gas into water within the pipe or vessel being treated. Chlorinating devices for feeding chlorine gas solution or the gas itself shall prevent of water into chlorine cylinder.

C. Use following proportions of hypochlorite or chlorine to water:
   1. Chlorine Gas or Liquid (100 Percent Cl): 1 pound per 1.75 gallons water.
      a. Apply liquid chlorine gas-water solution by means of a solution feed chlorinating device.
   2. Calcium Hypochlorite (65 to 70 Percent Cl): 1 pound per 7.5 gallons water.
      a. If calcium hypochlorite is used, first mix dry powder with water to make a thick paste, then thin to a 1 percent solution (10,000 ppm chlorine).
      a. If sodium hypochlorite procedure is used, dilute the liquid with water to obtain a 1 percent solution.

PART 3 - EXECUTION

3.1 GENERAL

A. Disinfect pumps and pipelines, installed or modified under this Project, intended to hold, transport, or otherwise contact potable water:
   1. Disinfect new pipelines that connect to existing pipelines up to the point of connection.
   2. Disinfect surfaces of materials that will contact finished water, both during and following construction using spray method described below.
   3. Disinfect prior to contact with finished water. Take care to avoid recontamination following disinfection.

B. Prior to application of disinfectants, clean equipment and pipelines of loose and suspended material. Flush pipelines until clear of suspended solids and color. Use water suitable for flushing and disinfecting.

C. Conform to AWWA C651 for pipes and pipelines, C652 for tanks and reservoirs, and AWWA C654 for wells, except as modified in these Specifications.

D. Allow freshwater and stock disinfectant solution to flow into the pipe or vessel at a measured rate so that the chlorine-water solution is at the specified strength. Do not place concentrated commercial disinfectant in the pipeline or vessel before it is filled with water.

3.2 PIPING AND PIPELINES

A. Flushing:
   1. Before disinfecting, flush all foreign matter from pipeline. Provide hoses, temporary pipes, ditches, and other conduits as needed to dispose of flushing water without damage to adjacent properties. Flushing velocities shall be at least 2.5 fps. For large diameter pipe, where it is impractical or impossible to flush the pipe at specified velocity, clean the pipeline in-place from the inside by brushing and sweeping, then flush the line.
   2. Flush pipelines through flushing branches and remove branches after flushing is completed. Operate valves during flushing process at least twice during each flush.
3. Flush service connections and hydrants. Flush distribution lines prior to flushing hydrants and service connections.

B. Disinfecting Solution: Chlorine-water solution having a free chlorine concentration of not less than 50 ppm.

C. Disinfecting Procedure: In accordance with AWWA C651, unless herein modified.

D. Point of Application:
   1. Inject chlorine mixture into pipeline to be treated at beginning of line through corporation stop or suitable tap in top of pipeline.
   2. Control water from existing system to flow slowly into pipeline during application of chlorine.
   3. Control rate of chlorine solution flow in proportion to rate of water entering pipe so that combined mixture shall contain not less than 50 ppm of free available chlorine.
   4. Prevent of chlorine solution into line supplying water.

E. Retention Period:
   1. Retain treated water in pipeline for at least 24 hours to destroy all nonspore-forming bacteria. At end of 24 hour period, disinfecting solution shall contain at least 10 ppm of free chlorine or the pipeline shall be recleaned, disinfecting solution shall be reapplied, and specified procedure repeated.
   2. Operate valves, hydrants, and appurtenances during disinfection to ensure that disinfecting solution is dispersed into all parts of the pipeline, including dead-ends and areas that otherwise may not be treated.
   3. After disinfection, flush water from the permanent source until water through the pipeline is equal chemically and bacteriologically to permanent source of supply.

3.3 PUMPS

A. Disinfecting Solutions: Minimum free chlorine concentration of 200 ppm.

B. Disinfecting Procedure: In accordance with AWWA unless herein modified.

C. Application:
   1. Inject the disinfecting solution into the pump and associated piping and circulate for a minimum 2 hour period of time. At the end of the 2 hour period, the solution shall have a strength of at least 100 ppm free chlorine.
   2. Operate valves and/or pump appurtenances during disinfection to ensure that the disinfecting solution is dispersed into all parts of the pumps and lines.
   3. If the disinfecting solution contained in the pumps has a residual free chlorine concentration less than 100 ppm after the 2 hour retention period, reclean the pump, reapply disinfecting solution, and retest until a satisfactory test result is obtained.
   4. After chlorination, flush the water from the pumps until the water through the units is chemically and bacteriologically equal to the permanent source of supply.

3.4 DISPOSAL OF DISINFECTING WASTEWATER

A. Do not allow flow into a waterway without neutralizing disinfectant residual.
   1. See AWWA C652 for acceptable neutralization methods.

3.5 TESTING

A. Test Equipment:
1. Clean containers and equipment used in sampling and assure they are free of contamination.
2. Obtain sampling bottles with instructions for handling from laboratory.

B. Chlorine Concentration Sampling and Analysis:
1. Sampling Frequency for Disinfecting Solution: Two samples per disinfecting procedure.
2. Residual Free Chlorine Samples: Two samples per disinfecting procedure.
3. Dechlorinated Disinfecting Wastewater Residual Samples: Two samples per disinfecting procedure.
4. Sampling Locations: Each 1,000 feet of pipeline or each building.
5. Analysis to be performed by the Owner’s laboratory.

C. After pipelines have been cleaned, disinfected, and refilled with potable water, Owner will take water Samples and have them analyzed for conformance to bacterial limitations for public drinking water supplies. Samples shall be analyzed for coliform concentrations in accordance with the latest edition of Standard Methods for the Examination of Water and Wastewater.
1. A minimum of two Samples on each of 2 consecutive days from each separable structure every 1,000 feet of pipeline will be obtained and analyzed by standard procedures outlined by state and local regulatory agencies.

D. If the minimum Samples required above are not bacterially negative, the disinfecting procedures and bacteriological testing shall be repeated on the respective facilities until bacterial limits are met.

END OF SECTION
SECTION 33 39 13 – CONCRETE MANHOLES

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes: the Work necessary to completely furnish and install cast-in-place manholes and pre-cast manholes and related items.

B. Related sections:
   1. Section 01 33 00 – Submittal Procedures.
   2. Section 01 60 00 – Product Requirements.
   3. Section 03 11 00 – Concrete Formwork.
   4. Section 03 20 00 – Concrete Reinforcement.
   5. Section 03 30 00 – Cast-In-Place Concrete.

1.2 GENERAL

A. Manholes shall be of diameter and constructed to elevations as shown on plans.

B. Pre-Cast or Cast-In-Place manholes are acceptable, however all manholes for this project shall be of like kind, unless otherwise stated in the Plans or as directed by the Engineer.

C. Manhole steps are not required and will not be accepted.

D. All materials shall equal or exceed the standards specified herein.

E. During the process of unloading, all manhole materials shall be inspected by the Contractor and any damaged material set aside.

F. All manholes where the top elevation is greater than two (2) feet above adjacent ground shall use hinged frames and cover as specified herein.

G. Inspection of materials at the manufacturer's plant, at the point of delivery, on the job site, or in place shall not relieve the Contractor of his responsibility and the material may be subject to rejection until final acceptance of the completed project.

1.3 SUBMITTALS

A. General: Administrative, shop drawings, samples, quality control, and contract closeout submittals shall conform to the requirements of Section 01 33 00, SUBMITTAL PROCEDURES.

B. In addition to the requirements of Section 01 33 00, SUBMITTAL PROCEDURES, submit the following additional specific information:
   1. Quality Control Submittals:
      a. Shop drawings for pre-cast manholes.
      b. Diameter, dimensions, and thickness.
      c. Reinforcement.
      d. Manhole frame and cover make and model.
      e. Concrete mix designs.
      f. Other materials used in construction of manholes.
      g. Special shipping, storage and protection, and handling instructions.
      h. Test procedures.
      i. Test results, reports, and certifications.
PART 2 - PRODUCTS

2.1 CAST-IN-PLACE MANHOLES

A. Concrete
   1. Concrete shall be as specified in 03 30 00, CAST-IN-PLACE CONCRETE.

B. Inverts
   1. Inverts shall be formed as shown on the detail drawings to the grades specified. Manholes with inverts not conforming to these grades may be subject to removal and replacement at the Contractor’s expense.
   2. Concrete for inverts shall be as specified in Section 03 30 00, CAST-IN-PLACE CONCRETE.

C. Pipe Connections
   1. Waterstop gaskets shall be required at ALL cast-in-place manhole connections. Manhole seals shall be concrete manhole adapter by Fernco, A-Lok, or equal.

2.2 PRE-CAST MANHOLES

A. Pre-cast manholes shall conform to ASTM C478 – Standard Specifications for Pre-Cast Reinforced Concrete Manhole Sections.

B. The top section shall be a concentric cone section conforming to ASTM C478.

C. Integral pre-cast floors shall be allowed, subject to the approval of Engineer. Cast-in-place floors shall be allowed.

D. Inverts may be pre-cast or field formed into the base section of the manhole, but in either case, shall meet the proper sewer line gradient and alignment shown in the Plans.

E. Precast concrete manhole sections shall not be delivered to the site until the sections are at least ten (10) days old. Two lift holes shall be cast into each cone or riser section for the purpose of handling and placing. The Contractor shall provide and install water plugs into lift holes after laying the sections.

F. Cutouts in the bottom sections shall be appropriate for the pipe being laid.
   1. Bottom sections shall have clear identifying markings to assure their being used in the right locations.
   2. Suitable openings for the inlet and outlet pipe shall be cored into the base section (and into the riser sections for drop or "pass-through" manholes).
   3. These openings shall be true size, circular and located as needed to maintain the proper sewer gradient for each manhole.
   4. Doghouse style bases shall only be used for manholes to be placed over existing sewer lines.

G. Each manhole shall be made up with as few risers as possible. The joints between risers shall be leak proofed with a mechanical water stop seal as approved by the Engineer and meeting the requirements of ASTM C443 and C361. There shall be a suitable spigot cast into the tongue of each component to contain the seal. The seal shall consist of a supporting compression section and a thin sliding flap which has been pre-lubricated. When the sections are fitted together, the edge of the bell shall encounter the flap which then slides towards the compression section.
H. No more than 8 inches of concentric rings shall be allowed to bring the manhole to finished grade.

I. Manhole Section Joints
1. Flexible rubber sealant for joints in pre-cast manhole sections shall provide permanently flexible watertight joints, shall remain workable over a wide temperature range and shall not shrink, harden or oxidize upon aging. Material shall be equal to RFS Prelubricated Gaskets by Press-Seal Gasket Corporation and shall meet ASTM C443 and ASTM C1619 (Classes C and E) requirements.
2. All manhole joints shall be sealed with an external joint wrap material, six (6) inch minimum width, material shall be Bidco Butyl Wrap as manufactured by NPC or approved equal.

J. Pipe Connections
1. Manufactured pipe-to-manhole connectors shall be installed at each opening to assure a flexible watertight seal of the pipe to the manhole.
2. The connector shall be capable of a 7-degree pipe deflection after installation without loss of sealing.
3. The connector shall be manufactured expressly for embedment in the wall of concrete manholes and shall be specifically designed for the pipe material and size being utilized on the project.
4. No adhesives or lubricants shall be employed in the installation of the connector into the manhole.
5. All stainless steel parts of the connector shall be totally non-magnetic Series 304 Stainless except the worm screw for tightening the steel band which shall be Series 305 Stainless. The worm screw shall be torqued by a break-away type torque wrench set for 60 – 70 in/lbs.
6. The connector shall be installed in the manhole so that it shall have a minimum cover of 3-inches of concrete at all points and in strict accordance with the manufacturer's recommendations.
7. Cutouts should be equipped with rubber boots to ensure a watertight connection. Material shall be A-Lok compression connector or A-Lok G3 Boot System, as manufactured by A-Lok Products, Inc or equal.

K. Rejecting Pre-cast Manhole Sections
1. Precast reinforced concrete manholes, risers and tops shall be subject to rejection for failure to conform to any of the following specification requirements:
   a. Fractures or cracks passing through the shell, except for a single end crack that does not exceed the depth of the joint;
   b. Defects that indicate imperfect proportioning, mixing and molding;
   c. Surface defects indicating honeycombed or open texture;
   d. Damaged ends, where such damage would prevent making a satisfactory joint;
   e. Infiltration into manhole exceeding allowed limits;
   f. The internal diameter of the manhole section shall not vary more than one (1) percent from the nominal diameter;
   g. Not clearly marked date of manufacturer, trade name, size designation part number, and ASTM number;
   h. Having a deviation more than 1/4” from the straight edge at any point across the top of manhole cone section or riser ring; and/or
   i. Having any visible steel bars along inside or outside surface of the manhole except for reinforcement stirrups or spacers used to position the cage during manufacture.

2.3 MANHOLE FRAMES AND COVERS

A. Standard Frames and Covers
1. Frames:
a. Frame material shall be cast iron or ductile iron conforming to ASTM A48, Class 35 or better. The frame shall exhibit a tensile strength of not less than 35,000 psi.
b. Frames for standard manholes shall be Deeter 1266 for non-traffic areas and Deeter 1235-A for traffic areas, or approved equal(s), and shall have 4 - ¾-inch diameter holes drilled in the bottom flange. The holes shall be centered in the flange and shall be equally spaced 90-degrees apart.
c. Bearing surfaces between the ring and cover shall be machine finished or ground to assure non-rocking fit in any position, and interchangeability.

2. Covers:
   a. The cover shall form a water resistant seal between the frame and manhole cover surface. The cover shall have concealed pick holes and a machined bearing surface on the bottom of the casting. The cover shall conform to ASTM A48, Class 35 or better, for Gray Iron. The cover shall have a tensile strength of 35,000 psi.
   b. A typical standard manhole cover design shall be Deeter 1266 for non-traffic areas and Deeter 1235-A for traffic areas or approved equal(s).
   c. Covers shall set flush with the rim of the frame and shall have no larger than a 1/8-inch gap between the frame and cover.
   d. Bearing surfaces shall be machine finished.

B. Hinged Manhole Frames and Covers
   1. Covers and frames shall conform to ASTM A48, Class 35 or better, for Gray Iron or equivalent ISO standard. Contractor shall provide verification of equivalency.
   2. Covers shall be hinged and incorporate a 90 degree blocking system to prevent accidental closure.
   3. Covers shall be one man operable using standard tools.
   4. Frames shall be circular with a 22-inch clear opening.
   5. The frame depth shall not exceed 4 inches, and the flange shall incorporate bedding slots, bolt holes and lifting eyes.
   6. Lids shall be lockable and lock/unlock hardware and tools shall be provided with each lid.

C. Manhole Frame Seals
   1. The material for the seals between the frames and concrete shall be a bitumastic gasket material, meeting or exceeding ASTM C990. Bitumastic gasket material shall be Ram-Nek, EZ-STIK, or approved equal.

2.4 COATINGS

A. Interior Coatings
   1. NOT USED

B. Exterior Coatings
   1. All precast manhole sections shall have the exterior coated with two mop coats of coal tar epoxy, Kop Coat “Bitumastic Black Solution,” Tnemec, “46-450 Heavy Tnemecol,” Carboline “Bitumastic 300M,” or equal. Dry film thickness shall be a minimum of 14.0 mils per coat. Recoating shall be done in accordance with manufacturer’s recommendations.

PART 3 - EXECUTION

3.1 GENERAL

A. Perform excavation and prepare base area in accordance with Section 31 23 16, EXCAVATION.

B. Never install base in a water filled excavation.
C. Place base in accordance with the Plans and Section 03 30 00, CAST-IN-PLACE CONCRETE. Extend base a minimum of six inches beyond finished sides of manhole.

D. Manhole base shall be placed on 8" of compacted crushed stone base meeting ASTM D-448 No. 57 stone.

E. Extend all pipes entirely through the manhole wall so that a joint occurs no closer than 24 inches outside the manhole wall.

F. Pipe installed for future extensions shall have one full joint of pipe installed.

G. After manhole is constructed, wait no less than 48 hours, then backfill per Section 31 23 23.13, FILL AND BACKFILL.

3.2 CAST-IN-PLACE MANHOLES

A. Dimension and layout shall be in accordance with the Plans. The top section or cone must be concentric with the barrel unless otherwise noted.

B. The frame shall be set in accordance with the Plans.

C. Install rubber waterstop gaskets in the walls around all pipes.

D. Interior finish shall be smooth, free of fins or sharp edges.

E. Invert to be constructed in accordance with Plans. The bench wall shall be formed to the spring line of the inlet and outlet pipes to form a "U" as shown in the Plans.

F. Care should be taken to prevent the end of the pipe from deflecting, due to loads imposed by the weight of the concrete.

G. Construction joints on manholes of excessive depth shall be connected with reinforcement approved by the Engineer.

3.3 PRE-CAST MANHOLES

A. Dimension and layout shall be in accordance with the plans. The top section or cone must be concentric with the barrel unless otherwise noted.

B. The bottom section for pre-cast manholes shall be manufactured as an integral part of the manhole base slab.

C. Install remaining sections in a truly vertical plane.

D. Fill space between pipe and periphery of cutout on the interior of the manhole with non-shrink grout from the bottom of the invert to the spring line of the sewer pipe (1/2 pipe depth).

E. Grout joints between sections, interior only.

F. Interior finish: smooth, free of fins or sharp edges.

G. Invert to be constructed in accordance with the Plans. The bench wall shall be formed to the spring line of the inlet and outlet pipes to form a "U" as shown in the Plans.

H. Grout and/or plug lifting holes for manholes.
I. All manhole joints shall be sealed with an external joint wrap material.

3.4 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. Comply with Section 01 60 00, PRODUCT REQUIREMENTS.

B. Delivery of Materials: Products shall be delivered in original, unbroken packages, containers, or bundles bearing the name of the manufacturer.

C. Storage: Products shall be carefully stored in a manner that will prevent damage and in an area that is protected from the elements.

3.5 FIELD QUALITY CONTROL

A. Contractor shall visually inspect all materials upon delivery and set aside and damaged or flawed materials and shall not install any damaged or flawed material.

END OF SECTION
SECTION 33 40 00 - STORM DRAINAGE PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes:
   1. Storm drainage piping, fittings, and accessories.
   2. Connection of drainage system to municipal sewers.
   3. Catch basins, paved area drainage, and site surface drainage.

B. Related sections:
   1. Section 01 33 00 – Submittals.
   2. Section 03 30 00 – Cast-In-Place Concrete.
   4. Section 31 23 23.13 – Fill and Backfill.

1.2 REFERENCES

A. The following is a list of standards which may be referenced in this section:
      a. ASTM C14 – Standard Specification for Nonreinforced Concrete Sewer, Storm Drain, and Culvert Pipe
      b. ASTM C76 – Standard Specification for Reinforced Concrete Culvert, Storm Drain and Sewer Pipe

1.3 DEFINITIONS

A. Bedding: Fill placed under, beside and directly over pipe, prior to subsequent backfill operations.

1.4 SUBMITTALS

A. See Section 01 33 00, SUBMITTALS for submittal procedures.

B. Product Data: Provide data indicating pipe, pipe accessories.

C. Manufacturer’s Installation Instructions: Indicate special procedures required to install Products specified.

D. Manufacturer’s Certificate: Certify that products meet or exceed specified requirements.

E. Project Record Documents:
   1. Record location of pipe runs, connections, catch basins, cleanouts, and invert elevations.
   2. Identify and describe unexpected variations to subsoil conditions or discovery of uncharted utilities.

1.5 REGULATORY REQUIREMENTS

A. Conform to applicable code for materials and installation of the Work of this section.
PART 2 - PRODUCTS

2.1 STORM SEWER PIPE MATERIALS

A. Reinforced Concrete Pipe: Shall meet ASTM C76, Class III, inside nominal diameter as indicated on drawings.

B. Reinforced Concrete Pipe Joint Device: ASTM C443 rubber compression gasket joint.

2.2 PIPE ACCESSORIES

A. Pipe Joints: Mechanical clamp ring type, stainless steel expanding and contracting sleeve, neoprene ribbed gasket for positive seal.

B. Fittings: Same material as pipe molded or formed to suit pipe size and end design, in required tee, bends, elbows, cleanouts, reducers, traps and other configurations required.

C. Trace Wire: Magnetic detectable conductor, clear plastic covering, imprinted with “Storm Sewer Service” in large letters.

2.3 CATCH BASIN, CLEANOUT, AND AREA DRAIN COMPONENTS

A. Lids and Drain Covers: Cast iron, hinged to cast iron frame.
   1. Catch Basin:
      a. Lid Design: Linear grill
   2. Cleanout:
      a. Lid Design: Linear grill.

B. Shaft Construction and Concentric cone Top Section: Reinforced precast concrete pipe sections, lipped male/female dry joints, nominal shaft diameter as indicated on drawings.

C. Base Pad: Cast-in-Place concrete of type specified in Section 03 30 00, leveled top surface to receive concrete shaft sections, sleeved to receive sanitary sewer pipe sections.

2.4 BEDDING AND BACKFILL MATERIALS

A. As specified in Section 31 23 23.16, TRENCH BACKFILL.

PART 3 - EXECUTIONS

3.1 TRENCHING

A. See Section 31 23 23.16, TRENCH BACKFILL, and Section 31 23 16.13, TRENCHING FOR SITE UTILITIES for additional requirements.

B. Backfill around sides and to top of pipe with cover fill, tamp in place and compact, then complete backfilling.

3.2 INSTALLATION – PIPE

A. Install pipe, fittings and accessories in accordance with manufacturer’s instructions. Seal watertight.

B. Lay pipe to slope gradients noted on layout drawings; with maximum variation from true slope of 1/8 inch in 10 feet.
C. Install continuous trace wire 6 inches above top of pipe; coordinate with Section 31 23 16.13.

3.3 INSTALLATION – CATCH BASINS AND CLEANOUTS

A. Form bottom of excavation clean and smooth to correct elevation.

B. Form and place cast-in-place concrete base pad, with provision for sanitary sewer pipe end sections.

C. Establish elevations and pipe inverts for inlets and outlets as indicated.

D. Mount lid and frame level in grout, secured to top cone section to elevation indicated.

3.4 FIELD QUALITY CONTROL

A. If tests indicate work does not meet specified requirements, remove Work, replace and retest at no cost to Owner.

3.5 PROTECTION

A. Protect pipe and bedding cover from damage or displacement until backfilling operation is in progress.

END OF SECTION
DIVISION 40
PROCESS INTEGRATION
SECTION 40 05 00 – PIPING SYSTEMS TESTING

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes: Test requirements for piping systems.

B. Related Sections:
   1. Section 01 41 00 – Regulatory Requirements.
   2. Section 01 50 00 – Temporary Facilities and Controls.

1.2 REFERENCES

A. National Fuel Gas Code (NFGC):
   1. ANSI Z 223.1 or NFPA 54.

B. American Society of Mechanical Engineers (ASME):
   2. B31.1 – Power Piping.

1.3 TESTING REQUIREMENTS

A. General Requirements:
   1. Testing requirements are stipulated in Laws and Regulations; are included in the Piping Schedule in Section 40 23 39, PROCESS PIPING - GENERAL; are specified in the specifications covering the various types of piping; and are specified herein.
   2. Requirements in Laws and Regulations supersede other requirements of Contract Documents, except where requirements of Contract Documents are more stringent, including higher test pressures, longer test times, and lower leakage allowances.
   3. Test plumbing piping in accordance with Laws and Regulations, the plumbing code, as specified in Section 01 41 00, REGULATORY REQUIREMENTS, and UL requirements.
   4. Test Natural Gas or Digester Gas Piping:
      a. For less than 125 pounds per square inch gauge working pressure, test in accordance with mechanical code, as specified in Section 01 41 00, REGULATORY REQUIREMENTS, or the National Fuel Gas Code, whichever is more stringent.
      b. For 125 pounds per square inch gauge or greater working pressure, test per ASME B31.3 or ASME B31.8, whichever is more stringent.
   5. When testing with water, the specified test pressure is considered to be the pressure at the highest point of the piping section under test. Lower test pressure as necessary to prevent testing the lowest point above a safe test pressure.

B. Furnish necessary personnel, materials, and equipment, including bulkheads, restraints, anchors, temporary connections, pumps, water, pressure gauges, and other means and facilities required to perform tests.

C. Water for Testing, Cleaning, and Disinfecting:
   1. Water for testing, cleaning, and disinfecting will be provided as specified in Section 01 50 00, TEMPORARY FACILITIES AND CONTROLS.

D. Pipes to be Tested: Test only those portions of pipes that have been installed as part of this Contract. Test new pipe sections prior to making final connections to existing piping. Furnish and
install test plugs, bulkheads, and restraints required to isolate new pipe sections. Do not use existing valves as test plug or bulkhead.

E. Unsuccessful Tests:
   1. Where tests are not successful, correct defects or remove defective piping and appurtenances and install piping and appurtenances that comply with the specified requirements.
   2. Repeat testing until tests are successful.

F. Test Completion: Drain and leave piping clean after successful testing.

G. Test Water Disposal: Dispose of testing water at the facility in accordance with requirements of federal, state, county, and city regulations governing disposal of wastes in the location of the Project and disposal site.

1.4 SUBMITTALS

A. Submit in accordance with Section 01 33 00, SUBMITTAL PROCEDURES.

B. Schedule and Notification of Tests:
   1. Submit a list of scheduled piping tests by noon of the working day preceding the date of the scheduled tests.
   2. Notification of Readiness to Test: Immediately before testing, notify Engineer in writing of readiness, not just intention, to test piping. Have personnel, materials, and equipment specified in place before submitting notification of readiness.

1.5 SEQUENCE

A. Clean piping before pressure or leak tests.

B. Test gravity piping underground, including sanitary sewers, for visible leaks before backfilling and compacting.

C. Underground pressure piping may be tested before or after backfilling when not indicated or specified otherwise.

D. Backfill and compact trench or provide blocking that prevents pipe movement before testing underground piping with a maximum leakage allowance.

E. Test underground piping before encasing piping in concrete or covering piping with slab, structure, or permanent improvement.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 TESTING, ALIGNMENT, GRADE, AND DEFLECTION

A. Alignment and Grade:
   1. Visually inspect the interior of gravity piping with artificial light, reflected light, or laser beam.
   2. Consider inspection complete when no broken or collapsed piping, no open or poorly made joints, no grade changes that affect the piping capacity, or no other defects are observed.

B. Deflection Test:
   1. Pull a mandrel through the clean piping section under test.
2. Perform the test not sooner than 30 days after installation and not later than 60 days after installation.
3. Use a 9-rod mandrel with a contact length of not less than the nominal diameter of the pipe within one percent plus or minus.
4. Consider test complete when the mandrel can be pulled through the piping with reasonable effort by 1 person, without the aid of mechanical equipment.

3.2 AIR TESTING METHOD FOR PRESSURE PIPING

A. Air test piping, indicated with "AM" in the Piping Schedule, with air or another nonflammable or inert gas.

B. Test gas, air, liquefied petroleum gas, liquid chlorine, and chlorine gas piping by the air test method:
   1. Test chlorine piping with dry air or nitrogen having a dew point of minus 40 degrees Fahrenheit or less. Supply temporary air dryers as necessary.

C. Test at pressure as specified in Piping Schedule in Section 40 23 39, PROCESS PIPING - GENERAL:
   1. Provide temporary pressure relief valve for piping under test. Set at the lesser of 110 percent of the test pressure or 50 pounds per square inch gauge over the test pressure.
   2. Air method test pressures shall not exceed 110 percent of the piping maximum allowable working pressure calculated in accordance with the most stringent of ASME B31.1, ASCE B31.3, ASEE B31.8, or the pipe manufacturer's stated maximum working pressure.
   3. Gradually increase test pressure to an initial test pressure equal to the lesser of one-half the test pressure or 25 pounds per square inch gauge.
   4. Perform initial check of joints and fittings for leakage.
   5. Gradually increase test pressure in steps no larger than the initial pressure. Check for leakage at each step increase until test pressure reached.
   6. At each step in the pressure, examine and test piping being air tested for leaks with soap solution.
   7. Consider examination complete when piping section under test holds the test pressure for 15 minutes without losses.

3.3 TESTING GRAVITY FLOW PIPING

A. Test Gravity Flow Piping indicated with "G" in the Piping Schedule, as follows:
   1. Unless specified otherwise, subject gravity flow piping to the following tests:
      a. Alignment and grade.
      b. For plastic piping test for deflection.
      c. Visible leaks and pressure with maximum leakage allowance, except for storm drains and culverts.
   2. Inspect piping for visible leaks before backfilling. Provide temporary restraints when needed to prevent movement of piping. Pressure test piping with maximum leakage allowance after backfilling.
   3. With the lower end plugged, fill piping slowly with water while allowing air to escape from high points. Keep piping full under a slight head for the water at least 24 hours.
      a. Examine piping for visible leaks. Consider examination complete when no visible leaks are observed.
      b. Maintain piping with water or allow a new water absorption period of 24 hours for the performance of the pressure test with maximum leakage allowance.
      c. After successful completion of the test for visible leaks and after the piping has been restrained and backfilled, subject piping to the test pressure for minimum of four hours while accurately measuring the volume of water added to maintain the test pressure.
1). Consider the test complete when leakage is equal to or less than the following maximum leakage allowances:
   a). For Concrete Piping with Rubber Gasket Joints: 80 gallons per day per inch of diameter per mile of piping under test.
      (1) Advise manufacturer of concrete piping with rubber gasket joints of more stringent than normal maximum leakage allowance.
      (2) For Vitrified Clay and Other Piping: 500 gallons per day per inch of diameter per mile of piping under test.

3.4 TESTING HIGH-HEAD PRESSURE PIPING

A. Test piping for which the specified test pressure in the Piping Schedule is 20 pounds per square inch gauge or greater, by the high head pressure test method, indicated “HH” in the Piping Schedule.

B. General:
   1. Test connections, hydrants, valves, blowoffs, and closure pieces with the piping.
   2. Do not use installed valves for shutoff when the specified test pressure exceeds the valve’s maximum allowable seat differential pressure. Provide blinds or other means to isolate test sections.
   3. Do not include valves, equipment or piping specialties in test sections if test pressure exceeds the valve, equipment or piping specialty safe test pressure allowed by the item’s manufacturer.
   4. During the performance of the tests, test pressure shall not vary more than plus or minus 5 pounds per square inch gauge with respect to the specified test pressure.
   5. Select the limits of testing to sections of piping. Select sections that have the same piping material and test pressure.
   6. When test results indicate failure of selected sections, limit tests to piping:
      a. Between valves.
      b. Between a valve and the end of the piping.
      c. Less than 500 feet long.
   7. Test piping for minimum of 2 hours for visible leaks test and minimum of 2 hours for the pressure test with maximum leakage allowance.

C. Testing Procedures:
   1. Fill piping section under test slowly with water while venting air. Use potable water for all potable waterlines and where noted on the Piping Schedule.
   2. Before pressurizing for the test, retain water in piping under slight pressure for a water absorption period of minimum 24 hours.
   3. Raise pressure to the specified test pressure and inspect piping visually for leaks. Consider visible leakage testing complete when no visible leaks are observed.

D. Pressure Test with Maximum Leakage Allowance:
   1. Leakage allowance is zero for piping systems using flanged, National Pipe Thread threaded and welded joints.
   2. Pressure test piping after completion of visible leaks test.
   3. For piping systems using joint designs other than flanged threaded or welded joints, accurately measure the makeup water necessary to maintain the pressure in the piping section under test during the pressure test period.
      a. Consider the pressure test to be complete when makeup water added is less than the allowable leakage and no damage to piping and appurtenances has occurred.
      b. Successful completion of the pressure test with maximum leakage allowance shall have been achieved when the observed leakage during the test period is equal or less than the allowable leakage and no damage to piping and appurtenances has occurred.
c. Successful completion of the pressure test with maximum leakage allowance shall have been achieved with the observed leakage during the test period is equal or less than the allowable leakage and no damage to piping and appurtenances has occurred.

d. When leakage is allowed, calculate the allowable leakage by the following formula:

\[ L = \frac{S D \sqrt{P}}{148,000} \]

Where:
- \( L \) = testing allowance (makeup water) (gph)
- \( S \) = length of pipe tested (ft)
- \( D \) = nominal diameter of the pipe (in.)
- \( P \) = average test pressure during the hydrostatic test (psi [gauge])

3.5 TESTING LOW-HEAD PRESSURE PIPING

A. Test piping for which the specified test pressure is less than 20 pounds per square inch gauge, by the low head pressure test method, indicated "LH" in the Piping Schedule.

B. General:
1. Test pressures shall be as scheduled in Section 40 23 39, PROCESS PIPING – GENERAL.
2. During the performance of the tests, test pressure shall not vary more than plus or minus 2 pounds per square inch gauge with respect to the specified test pressure.
3. Test connections, blowoffs, vents, closure pieces, and joints into structures, including existing bell rings and other appurtenances, with the piping.
4. Test piping for minimum of 2 hours for visible leaks test and minimum of 2 hours for the pressure test with maximum leakage allowance.

C. Visible Leaks Test:
1. Subject piping under test to the specified pressure measured at the lowest end.
2. Fill piping section under test slowly with water while venting air. Use potable water for all potable waterlines and where noted on the Piping Schedule.
3. Before pressurizing for the tests, retain water in piping under slight pressure for the water absorption period of minimum 24 hours.
4. Raise pressure to the specified test pressure and inspect piping visually for leaks. Consider testing complete when no visible leaks are observed.

D. Pressure Test with Maximum Leakage Allowance:
1. Pressure test piping after completion of visible leaks test.
2. Accurately measure the makeup water necessary to maintain the pressure in the piping section under test during the test period.
   a. Consider the pressure test to be complete when makeup water added is less than the allowable leakage of 80 gallons per inch of nominal diameter, per mile of piping section under test after 24 hours and no damage to piping and appurtenances has occurred.
   b. Successful completion of the leakage test shall have been achieved when the observed leakage is equal or less than the allowable leakage and no damage to piping and appurtenances has occurred.

E. Optional Joint Test:
1. When joint testing is allowed by note in the piping schedule, the procedure shall be as follows:
   a. Joint testing will be allowed only for low head pressure piping.
   b. Joint testing may be performed with water or air.
   c. Joint test piping after completion of backfill and compaction to the top of the trench.
d. Joint Testing with Water:
   1). Measure test pressure at the invert of the pipe. Apply pressure of 4 feet plus the inside diameter of the pipe in water column within 0.20 feet in water column.
   2). Maintain test pressure for one minute.
   3). Base the allowable leakage per joint on 80 gallons per inch nominal diameter, per mile of piping, per 24 hours equally distributed to the actual number of joints per mile for the type of piping.
   4). Consider the pressure test to be complete when makeup water added is less than the allowable leakage.
   5). Successful completion of the joint test with water shall have been achieved when the observed leakage is equal or less than the allowable leakage.

e. Joint Testing with Air:
   1). Apply test pressure of 3 pounds per square inch gauge with a maximum variation of plus 0.20 and minus 0.00 pounds per square inch.
   2). Maintain test pressure for 2 minutes.
   3). Consider the pressure test to be complete when the test pressure does not drop below 2.7 pounds per square inch for the duration of the test.
SECTION 40 05 13 - COMMON WORK RESULTS FOR PROCESS PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. This Section specifies piping materials and installation methods common to more than one section of Division 40 and includes joining materials, piping specialties, and basic piping installation instructions.

B. Related Sections:
1. Piping materials and installation methods peculiar to individual systems are specified within their respective system specification sections of Division 40.
2. Valves are specified in a separate section and in individual piping system sections of Division 40.
3. Supports and Anchors are specified in a separate section of Division 40.
4. Mechanical Identification is specified in a separate section of Division 40.
5. Fire Barrier Penetration Seals are specified in Division 07.

1.2 SUBMITTALS

A. Refer to Division 01 and Basic Mechanical Requirements for administrative and procedural requirements for submittals.

B. Product Data: Submit product data on the following items:
1. Escutcheons
2. Dielectric Unions and Fittings
3. Mechanical Sleeve Seals

C. Quality Control Submittals:
1. Submit welders’ certificates specified in Quality Assurance below.

1.3 QUALITY ASSURANCE

A. Welder’s Qualifications: All welders shall be qualified in accordance with ASME Boiler and Pressure Vessel Code, Section IX, Welding and Brazing Qualifications.


1.4 DELIVERY, STORAGE, AND HANDLING

A. Provide factory-applied plastic end-caps on each length of pipe and tube, except for concrete, corrugated metal, hub-and-spigot, clay pipe. Maintain end-caps through shipping, storage and handling to prevent pipe-end damage and prevent entrance of dirt, debris, and moisture.

B. Protect stored pipes and tubes. Elevate above grade and enclose with durable, waterproof wrapping. When stored inside, do not exceed structural capacity of the floor.

C. Protect flanges, fittings, and specialties from moisture and dirt by inside storage and enclosure, or by packaging with durable, waterproof wrapping.
PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, Manufacturers offering piping materials and specialties which may be incorporated in the work include, but are not limited to, the following:

B. Pipe Escutcheons:
   3. Grinnell

C. Dielectric Waterway Fittings:
   1. Epco Sales, Inc.
   2. Victaulic Company of America

D. Dielectric Unions:
   1. Eclipse, Inc.
   2. Perfection Corp.
   3. Watts Regulator Co.

E. Mechanical Sleeve Seals:
   1. Thunderline Corp.

2.2 PIPE AND FITTINGS

A. Refer to the individual piping system specification sections in Division 40 for specifications on piping and fittings relative to that particular system.

2.3 JOINING MATERIALS

A. Welding Materials: Comply with Section II, Part C, ASME Boiler and Pressure Vessel Code for welding materials appropriate for the wall thickness and chemical analysis of the pipe being welded.

B. Brazing Materials: Comply with SFA-5.8, Section II, ASME Boiler and Pressure Vessel Code for brazing filler metal materials appropriate for the materials being joined.

C. Soldering Materials: Refer to individual piping system specifications for solder appropriate for each respective system.

D. Gaskets for Flanged Joints: Gasket material shall be full-faced for cast-iron flanges and raised-face for steel flanges. Select materials to suit the service of the piping system in which installed and which conform to their respective ANSI Standard (A21.11, B16.20, or B16.21). Provide materials that will not be detrimentally affected by the chemical and thermal conditions of the fluid being carried.

2.4 PIPING SPECIALTIES

A. Escutcheons: Chrome-plated, stamped steel, hinged, split-ring escutcheon, with set screw. Inside diameter shall closely fit pipe outside diameter or outside of pipe insulation where pipe is insulated. Outside diameter shall completely cover the opening in floors, walls, or ceilings.
B. Unions: Malleable-iron, Class 150 for low pressure service and class 250 for high pressure service; hexagonal stock, with ball-and-socket joints, metal-to-metal bronze seating surfaces; female threaded ends.

C. Dielectric Unions: Provide dielectric unions with appropriate end connections for the pipe materials in which installed (screwed, soldered, or flanged), which effectively isolate dissimilar metals, prevent galvanic action, and stop corrosion.

D. Dielectric Waterway Fittings: electroplated steel or brass nipple, with an inert and non-corrosive, thermoplastic lining.

E. Sleeves:
   1. Sheet-Metal Sleeves: 10 gauge, galvanized sheet metal, round tube closed with welded longitudinal joint.
   2. Steel Sleeves: Schedule 40 galvanized, welded steel pipe, ASTM A53, Grade A.
   3. Mechanical Sleeve Seals: Modular mechanical type, consisting of interlocking synthetic rubber links shaped to continuously fill annular space between pipe and sleeve, connected with bolts and pressure plates which cause rubber sealing elements to expand when tightened, providing watertight seal and electrical insulation.

PART 3 - EXECUTION

3.1 PREPARATION

A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

B. Remove scale, slag, dirt, and debris for both inside and outside of piping and fittings before assembly.

3.2 INSTALLATION

A. General Locations and Arrangements: Drawings (plans, schematics, and diagrams) indicate the general location and arrangement of the piping systems. Location and arrangement of piping layout take into consideration pipe sizing and friction loss, expansion, pump sizing, and other design considerations. So far as practical, install piping as indicated. Refer to individual system specifications for requirements for coordination drawing submittals.
   1. Conceal all pipe installations in walls, pipe chases, utility spaces, above ceilings, below grade or floors, unless indicated otherwise.
   2. Install piping free of sags or bends and with ample space between piping to permit proper insulation applications.
   3. Install exposed piping at right angles or parallel to building walls. Diagonal runs are not permitted, unless expressly indicated on the Drawings.
   4. Install piping tight to slabs, beams, joists, columns, walls, and other permanent elements of the building. Provide space to permit insulation applications, with 1" clearance outside the insulation. Allow sufficient space above removable ceiling panels to allow for panel removal.
   5. Locate groups of pipes parallel to each other, spaced to permit applying full insulation and servicing of valves.
   6. Install drains at low points in mains, risers, and branch lines consisting of a tee fitting, 3/4" ball valve, and short 3/4" threaded nipple and cap.

B. Exterior Wall Penetrations: Seal pipe penetrations through exterior walls using sleeves and mechanical sleeve seals. Pipe sleeves smaller than 6" shall be steel; pipe sleeves 6" and larger shall be sheet metal.
C. Fire Barrier Penetrations: Where pipes pass through fire rated walls, partitions, ceilings, or floors, the fire rated integrity shall be maintained. Refer to Division 07 for special sealers and materials.

3.3 FITTINGS AND SPECIALTIES

A. Use fittings for all changes in direction and all branch connections.

B. Remake leaking joints using new materials.

C. Install strainers on the supply side of each control valve, pressure reducing or regulating valve, solenoid valve, and elsewhere as indicated.

D. Install unions adjacent to each valve and at the final connection to each piece of equipment and plumbing fixture having 2" and smaller connections, and elsewhere as indicated.

E. Install Flanges in piping 2-1/2" and larger, where indicated, adjacent to each valve, and at the final connection to each piece of equipment.

F. Install dielectric unions to connect piping materials of dissimilar metals in dry piping systems (gas, compressed air, vacuum).

G. Install dielectric fittings to connect piping materials of dissimilar metals in wet piping systems (water, steam).

3.4 JOINTS

A. Steel Pipe Joints:
   1. Pipe 2" and Smaller: Thread pipe with tapered pipe threads in accordance with ANSI B2.1. Cut threads full and clean using sharp dies. Ream threaded ends to remove burrs and restore full inside diameter. Apply pipe joint lubricant or sealant suitable for the service for which the pipe is intended on the male threads at each joint and tighten joint to leave not more than 3 threads exposed.
   2. Pipe Larger Than 2": Weld pipe joints (except for exterior water service pipe) in accordance with ASME Code for Pressure Piping, B31.
   3. Weld pipe joints of exterior water service pipe in accordance with AWWA C206.
   4. Install flanges on all valves, apparatus, and equipment. Weld pipe flanges to pipe ends in accordance with ASME B31.1.0 Code for Pressure Piping. Clean flange faces and install gaskets. Tighten bolts to torque specified by manufacturer of flange and flange bolts, to provide uniform compression of gaskets.

B. Non-ferrous Pipe Joints
   2. Thoroughly clean tube surface and inside surface of the cup of the fittings, using very fine Emory cloth prior to making soldered or brazed joints. Wipe tube and fittings clean and apply flux. Flux shall not be used as the sole means for cleaning tube and fitting surfaces.

C. Mechanical Joints: Flared compression fittings may be used for refrigerant lines 3/4" and smaller.

D. Joints for other piping materials are specified within the respective piping system sections.
3.5 FIELD QUALITY CONTROL

A. Testing: Refer to individual piping system specification sections.

END OF SECTION
SECTION 40 23 39 - PROCESS PIPING - GENERAL

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes: Basic Process Piping Materials, Methods, and Appurtenances.

B. Related sections:
   1. Section 01 60 00 – Product Requirements.
   2. Section 03 30 00 – Cast-In-Place Concrete.
   3. Section 09 90 00 – Painting and Protective Coatings.
   4. Section 22 05 29 – Process Supports and Anchors.
   5. Section 31 23 23.16 – Trench Backfill.
   7. Section 40 41 13 – Heat Tracing.
   8. Section 40 24 00 – Process Piping Specialties.
   9. Section 40 42 00 – Process Mechanical Insulation.

1.2 OWNER FURNISHED MATERIALS

A. Owner has pre-purchased portions of the piping systems to be provided to the Contractor for installation. The detailed scope of supply for Owner furnished items is provided in the designated volume of the project documents. The Contractor shall carefully review the scope of supply to determine those items required by the Contract Documents which are not part of the proposal or specified manufacturer’s scope of supply. Costs for installation of Owner furnished materials shall be included in the relevant Lump Sum Bid Price items of the bid form and shall include costs for the following:
   1. All items not specifically itemized in the Owner’s scope of supply but required by the Contract Documents and/or necessary to provide a complete and operational system.
   2. All items specifically itemized in the Owner’s scope of supply which are designated to be provided by others, provided by the customer, or any similar designation.
   3. All labor, materials, and all other associated costs not included in the Scope of Supply but required by the Contract Documents and required to provide a complete and operational system.

1.3 REFERENCES

A. The following is a list of standards which may be referenced in this Section and any supplemental Data Sheets:
      a. A21.52, Ductile Iron Pipe, Centrifugally Cast, for Gas.
      b. B1.20.1, Pipe Threads, General Purpose (Inch).
      e. B16.5, Pipe Flanges and Flanged Fittings.
      g. B16.11, Forged Fittings, Socket-Welding and Threaded.
      h. B16.15, Cast Bronze Threaded Fittings, Classes 125 and 250.
      i. B16.21, Nonmetallic Flat Gaskets for Pipe Flanges.
      k. B16.24, Cast Copper Alloy Pipe Flanges and Flanged Fittings Class 150,300,400,600,900, 1500 and 2500.
      l. B16.25, Butt Welding Ends.
m. B16.42, Ductile Iron Pipe Flanges and Flanged Fittings, Classes 150 and 300.


4. American Society of Mechanical Engineers (ASME):
   a. Boiler and Pressure Vessel Code, Section VITI, Division 1, Pressure Vessels.
   b. Boiler and Pressure Vessel Code, Section IX, Welding and Brazing Qualifications.
   c. B31.1, Power Piping.
   e. B31.9, Building Services Piping.
   f. B36.10M, Welded and Seamless Wrought Steel Pipe.


   m. A194/A194M, Standard Specification for Carbon and Alloy Steel Nuts for Bolts for High-Pressure and High-Temperature Service.
z. A409/ A409M, Standard Specification for Welded Large Diameter Austenitic Steel Pipe for Corrosive or High-Temperature Service.
ii. B62, Standard Specification for Composition Bronzed or Ounce Metal Castings.
r. D1785, Standard Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120.
ss. D2000, Standard Classification System for Rubber Products in Automotive Applications.
1.4 DEFINITIONS

A. Submerged or Wetted:
   1. Zone below elevation of:
      a. Top face of channel walls and cover slabs.
      b. Top face of basin walkways.
      c. Top face of clarifier walkways.
      d. Top face of digester walls, including structure piping penetrations.
      e. Liquid surface or within 2 feet above top of liquid surface.
      f. Top of tank wall or under tank cover.

1.5 SUBMITTALS

A. Shop Drawings:
   1. Shop Fabricated Piping:
      a. Detailed pipe fabrication or spool drawings showing special fittings and bends, dimensions, coatings, and other pertinent information.
      b. Layout drawing showing location of each pipe section and each special length; number or otherwise designate laying sequence on each piece.
2. Pipe Wall Thickness: Identify wall thickness and rational method or standard applied to determine wall thickness for each size of each different service including exposed, submerged, buried, and concrete-encased installations for Contractor-designed piping.


4. Thrust Blocks: Concrete quantity, bearing area on pipe, and fitting joint locations.

5. Dissimilar Buried Pipe Joints: Joint types and assembly drawings.

6. Gasket material, temperature rating, and pressure rating for each type of pipe and each type of service.

B. Quality Control Submittals:
1. Manufacturer's Certification of Compliance.
2. Qualifications:
   b. Welding Inspector: Certification and qualifications.
   c. Welders:
      1). List of qualified welders and welding operators.
      2). Current test records for qualified welder(s) and weld type(s) for factory and field welding.

3. Weld Procedures: Records in accordance with ASME Boiler and Pressure Vessel Code, Section IX for weld type(s) and base metal(s).

4. Nondestructive inspection and testing procedures.

5. Manufacturer's Certification of Compliance:
   a. Pipe and fittings.
   b. Factory applied resins and coatings.

6. Certified weld inspection and test reports.

7. Test logs.

1.6 QUALITY ASSURANCE

A. Weld Inspection and Testing Laboratory Qualifications:
1. Retain approved independent testing laboratory that will provide the services of an AWS certified welding inspector qualified in accordance with AWS QC1 with prior inspection experience of welds specified herein.

2. Perform weld examinations with qualified testing personnel who will carry out radiography, ultrasonic, magnetic particle, and other nondestructive testing methods as specified herein.

3. Welding Inspector:
   a. Be present when shop or field welding is performed to certify that welding is in accordance with specified standards and requirements.
   b. Duties include, but are not limited to, the following:
      1). Job material verification and storage.
      2). Qualification of welders.
      3). Certify conformance with approved welding procedure specifications.
      4). Maintain records and prepare reports in a timely manner.
      5). Notify Engineer within 1 hour of discovery of unsatisfactory weld performance and within 24 hours of weld test failure.
      6). Supervision of testing personnel.

B. Welder and Welding Operator Performance:
1. Qualify welders and welding operators by approved testing laboratory before performing any welding under this section.

2. Perform welder qualification tests in accordance with Section IX, Article III of the ASME Boiler and Pressure Vessel Code.

3. Qualification tests may be waived if evidence of prior qualification is deemed suitable by the Engineer.
4. Qualify welders and operators in the performance of making groove welds in each different pipe material, including carbon steel pipe, in Positions 2G and 5G for each welding process to be used.

5. Qualify welders and welding operators for stainless steel as stated herein on the type of stainless steel being welded with the welding process used.

C. Certifications:
   1. Coal-Tar Epoxy Applicator: Certified by Piping Manufacturer to be qualified to apply coal-tar epoxy coating to submerged or embedded ductile iron or cast iron soil piping.
   2. Weld Testing Agency: Certified in accordance with current American Society for Nondestructive Testing (4153 Arlingate Plaza, Columbus, OH 43228) recommended practice SNT-TC-1A, NDT Level II.

D. Quality Control Submittals:
   1. Manufacturer’s Certification of Compliance.
   2. Laboratory Testing Equipment: Certified calibrations, Manufacturer’s product data, and test procedures.
   3. Certified welding inspection and test results.
   4. Qualifications:
      b. Welding Inspector: Certification and qualifications.
      c. Welders:
         1) List of qualified welders and welding operators.
         2) Current test records for qualified welder(s) and weld type(s) for factory and field welding.
   5. Weld Procedures: Records in accordance with ASME Boiler and Pressure Vessel Code, Section IX for weld type(s) and base metal(s).
   6. Nondestructive inspection and testing procedures.
   7. Manufacturer’s Certification of Compliance:
      a. Pipe and fittings.
      b. Welding electrodes and filler materials.
      c. Factory applied resins and coatings.
   8. Certified weld inspection and test reports.

1.7 DELIVERY, STORAGE, AND HANDLING

A. In accordance with Section 01 60 00, PRODUCT REQUIREMENTS, and:
   1. Flanges: Securely attach metal, hardboard, or wood protectors over entire gasket surface.
   2. Threaded or Socket Welding Ends: Fit with metal, wood, or plastic plugs or caps.
   4. Cold Weather Storage: Locate products to prevent coating from freezing to ground.
   5. Handling: Use heavy canvas or nylon slings to lift pipe and fittings.

PART 2 - PRODUCTS

2.1 PIPING

A. As specified on Piping Data Sheet(s) and Piping Schedule located at the end of this section as Supplement.

B. Diameters Shown:
   2. Fabricated Steel Piping (Except Cement-Lined): Outside diameter, ASME 836.10M.
2.2 JOINTS

A. Grooved End System:
   1. Rigid, except where joints are used to correct misalignment, to provide flexibility, or where shown, furnish flexible type.
   2. Flanges: When required, furnish with grooved type flange adapters of same manufacturer as grooved end couplings.

B. Flanged Joints:
   1. Flanges for ductile iron pipe shall conform to AWWA C115 at pressure rating meeting requirements of the connecting piping.
   2. Flanges for steel pipe shall conform to ANSI/ASME B16.5 at pressure rating meeting requirements of the connecting piping.
   3. Higher pressure rated flanges as required, to mate with equipment when equipment flange is of higher pressure rating than required for piping.

C. Threaded Joints: NPT taper pipe threads in accordance with ANSI B 1.20. 1.

D. Thrust Tie-Rod Assemblies: NFPA 24; tie-rod attachments relying on clamp friction with pipe barrel to restrain thrust are unacceptable.

E. Mechanical Joint Anchor Gland Follower:
   1. Ductile iron anchor type, wedge action, with break off tightening bolts.

F. Flexible Mechanical Compression Joint Coupling:
   1. Stainless steel, ASTM A276, Type 305 bands.
   2. Manufacturers:
      a. Pipeline Products Corp.
      b. Ferno Joint Sealer Co.

G. Mechanical connections of the high density polyethylene pipe to auxiliary equipment such as valves, pumps, tanks, and other piping systems shall be through flanged connections consisting of the following:
   1. A polyethylene stub end thermally butt-fused to the end of the pipe.
   2. ASTM A240, Type 304 stainless steel backing flange, 125-pound, ANSI B16.1 Standard. Insulating flanges shall be used where shown.
   3. Bolts and nuts of sufficient length to show a minimum of three complete threads when the joint is made and tightened to the Manufacturer’s standard. Re-torque the nuts after 4 hours.
   4. Gaskets as specified on Data Sheet.
   5. Connection to buried mechanical joint fittings and valves shall be by restrained mechanical joint follower glad designed for HDPE pipe. Provide stainless steel stiffener as required by pipe manufacturer.

2.3 COUPLINGS

A. Steel Middle Rings and Followers:
   1. Fusion bonded, epoxy-lined, and coated in accordance with Section 09 90 00, PAINTING AND PROTECTIVE COATINGS.

B. Flexible Couplings:
   1. Manufacturers and Products:
      a. Steel Pipe:
         1) Dresser; Style 38.
2). Smith-Blair; Style 411.
3). Romac 501

b. Ductile Iron Pipe:
1). Dresser; Style 38.
2). Smith-Blair; Style 411.
3). Romac 501

C. Transition Couplings:
1. Manufacturers and Products:
   a. Dresser; Style 62.
   b. Smith-Blair; Style 413.
   c. Romac RC501

D. Flanged Coupling Adapters:
1. Manufacturers and Products:
   a. Steel Pipe:
      1). Smith-Blair; Series 913.
      2). Dresser Industries, Inc.; Style 128-W.
      3). Romac FC400
   b. Ductile Iron Pipe:
      1). Smith-Blair; Series 912.
      2). Dresser Industries, Inc.; Style 128-W.
      3). Romac FCA501

E. Dismantling Joints:
1. Manufacturers and Products:
   a. Steel or Ductile Iron Pipe:
      1). Smith-Blair; Series 975.
      2). Dresser Industries, Inc.; Style 131.
      3). Romac DJ400.

2.4 HARDWARE

A. All hardware on submerged piping or piping below the top elevation of tanks and directly exposed to water, wastewater and/or wastewater solids, including but not limited to bolts, nuts, washers, and threaded rod shall be stainless steel.

2.5 GASKET LUBRICANT

A. Lubricant shall be supplied by pipe Manufacturer and no substitute or “or-equal” will be allowed.

2.6 DOUBLE WALL CONTAINMENT PIPING SYSTEM

A. All system components shall be pre-engineered, factory fabricated, tested, and assembled such that field assembly is minimized to primarily that of straight joints.

2.7 THRUST RESTRAINT

A. Buried piping shall be restrained joint piping unless specified otherwise or when connecting to existing pipe lines. When connecting to existing pipe lines concrete thrust blocking shall be used as specified in Section 03 30 00, CAST-IN-PLACE CONCRETE.

B. All above grade piping shall be adequately restrained and supported.
2.8 VENT AND DRAIN VALVES

A. Pipeline 2-1/2” Diameter and Larger: Vent connections shall be 3/4-inch with V300 ball valve. Drain connection shall be 1-inch with V300 ball valve, unless shown otherwise.

B. Pipeline 2” Diameter and Smaller: Vent connections shall be 1/2-inch with V300 ball valve. Drain connection shall be 1-inch with V300 ball valve, unless shown otherwise.

C. Provide galvanized steel pipe plug in each ball valve.

2.9 FABRICATION

A. Mark each pipe length on outside:
   1. Size or diameter and class.
   2. Manufacturer’s identification and pipe serial number.
   3. Location number on laying drawing.
   4. Date of manufacture.

B. Code markings according to approved Shop Drawings.

C. Flanged pipe shall be fabricated in the shop, not in the field, and delivered to the site with flanges in place and properly faced. Threaded flanges shall be individually fitted and machine tightened on matching threaded pipe by the Manufacturer.

2.10 FINISHES

A. Factory prepare, prime, and finish coat in accordance with Pipe Data Sheet(s), Piping Schedule, and Section 09 90 00, PAINTING AND PROTECTIVE COATINGS.

B. Galvanizing:
   1. Hot-dip applied, meeting requirements of ASTM A153.
   2. Electroplated zinc or cadmium plating is unacceptable.
   3. Stainless steel components may be substituted where galvanizing is specified.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify size, material, joint types, elevation, horizontal location, and pipe service of existing pipelines to be connected to new pipelines or new equipment.

B. Inspect size and location of structure penetrations to verify adequacy of wall pipes, sleeves, and other openings.

C. Welding Electrodes: Verify proper grade and type, free of moisture and dampness, and coating is undamaged.

3.2 PREPARATION

A. Notify Engineer at least 2 weeks prior to field fabrication of pipe or fittings.

B. Inspect pipe and fittings before installation, clean ends thoroughly, and remove foreign matter and dirt from inside.
C. Damaged Coatings and Linings: Repair using original coating and lining materials in accordance with Manufacturer’s instructions, except for damaged glass-lined pipe or PVDF-lined pipe that is to be promptly removed from the site.

3.3 WELDING

A. Perform in accordance with Section IX, ASME Boiler and Pressure Vessel Code and ASME B31.1 for Pressure Piping, as may be specified on Piping Data Sheets, and if recommended by piping or fitting Manufacturer.

B. Weld Identification: Mark each weld with symbol identifying welder.

C. Pipe End Preparation:
   2. Oxygen or Arc Cutting: Smooth to touch, true, and slag removal by chipping or grinding.

D. Surfaces:
   1. Clean and free of paint, oil, rust, scale, slag, or other material detrimental to welding.
   2. Clean stainless steel joints with stainless steel wire brushes or stainless steel wool prior to welding.
   3. Thoroughly clean each layer of deposited weld metal, including final pass, prior to deposition of each additional layer of weld metal with a power-driven wire brush.

E. Alignment and Spacing:
   1. Align ends to be joined within existing commercial tolerances on diameters, wall thicknesses, and out-of-roundness.
   2. Root Opening of Joint: As stated in qualified welding procedure.
   3. Minimum Spacing of Circumferential Butt Welds: Minimum four times pipe wall thickness or 1", whichever is greater.

F. Climatic Conditions:
   1. Do not perform welding if there is impingement of any rain, snow, sleet or high wind on the weld area, or if the ambient temperature is below 32 °F.
   2. Stainless Steel and Alloy Piping: If the ambient is less than 32° F, local preheating to a temperature warm to the hand is required.

G. Tack Welds: Performed by qualified welder using same procedure as for completed weld, made with electrode similar or equivalent to electrode to be used for first weld pass, and not defective. Remove those not meeting requirements prior to commencing welding procedures.

H. Surface Defects: Chip or grind out those affecting soundness of weld.

I. Weld Passes: As required in welding procedure.

J. Weld Quality: Free of cracks, incomplete penetration, weld undercutting, excessive weld reinforcement, porosity slag inclusions, and other defects in excess of limits shown in applicable piping code.

3.4 INSTALLATION - GENERAL

A. Join pipe and fittings in accordance with Manufacturer’s instructions, unless otherwise shown or specified.

B. Remove foreign objects prior to assembly and installation.
C. Flanged Joints:
   1. Install perpendicular to pipe centerline.
   2. Bolt Holes: Straddle vertical centerlines, aligned with connecting equipment flanges or as shown.
   3. Use torque-limiting wrenches to ensure uniform bearing and proper bolt tightness.
   4. Plastic Flanges: Install annular ring filler gasket at joints of raised-face flange.
   5. Raised-Face Flanges: Use flat-face flange when joining with flat-faced ductile or cast-iron flange.

D. Threaded and Coupled Joints:
   2. Produce sufficient thread length to ensure full engagement when screwed home in fittings.
   3. Countersink pipe ends, ream and clean chips and burrs after threading.
   4. Make connections with not more than three threads exposed.
   5. Lubricate male threads only with thread lubricant or tape as specified on Piping Data Sheets.

E. Soldered Joints:
   1. Use only solder specified for particular service.
   2. Cut pipe ends square and remove fins and burrs.
   3. After thoroughly cleaning pipe and fitting of oil and grease using solvent and emery cloth, apply non-corrosive flux to the male end only.
   4. Wipe excess solder from exterior of joint before hardened.
   5. Before soldering, remove stems and washers from solder joint valves.

F. Couplings:
   1. General:
      a. Install in accordance with Manufacturer’s written instructions.
      b. Before coupling, clean pipe holdback area of oil, scale, rust, and dirt.
      c. Remove pipe coating if necessary to present smooth surface.
   2. Application:
      c. Concrete Encased Couplings: Sleeve type coupling.
      d. Corrosive Service Piping: Elastomer bellows connector.
      e. Grit Slurry Piping: Elastomer bellows connector.

G. Pipe Connections at Concrete Structures: As specified in article PIPING FLEXIBILITY PROVISIONS in Section 40 24 00, PROCESS PIPING SPECIALTIES.

H. Penetrations:
   1. Watertight Penetrations:
      a. Provide wall pipes with thrust collars, as specified in Section 40 24 00, PROCESS PIPING SPECIALTIES.
      b. Provide taps for stud bolts in flanges to be set flush with wall face.
   2. Non-watertight Penetrations:
      a. Pipe sleeves with seep ring as specified in Section 40 24 00, PROCESS PIPING SPECIALTIES.
      b. Pipe sleeves with modular mechanical seal may be provided where fabrication of seep ring on pipe sleeve is impractical.
   3. Existing Walls:
      a. Rotary drilled holes with modular mechanical seal as specified in Section 40 24 00, PROCESS PIPING SPECIALTIES.
4. Fire-Rated or Smoke-Rated Walls, Floor, or Ceilings: Insulated and encased pipe sleeves as specified in Section 40 24 00, PROCESS PIPING SPECIALTIES.

I. PVC and CPVC Piping:
   1. Provide Schedule 80 threaded nipple where necessary to connect to threaded valve or fitting.
   2. Use strap wrench for tightening threaded plastic joints. Do not over tighten fittings.
   3. Do not thread Schedule 40 pipe.

J. Ductile Iron, Cement-Lined Ductile Iron, and Glass-Lined Ductile Iron Piping:
   1. Cutting Pipe: Cut pipe with milling type cutter, rolling pipe cutter, or abrasive saw cutter. Do not flame cut.
   2. Dressing Cut Ends:
      a. General: As required for the type of joint to be made.
      b. Rubber Gasketed Joints: Remove sharp edges or projections.
      c. Push-On Joints: Bevel, as recommended by pipe Manufacturer.
      d. Flexible Couplings, Flanged Coupling Adapters, and Grooved End Pipe Couplings: As recommended by the coupling or adapter Manufacturer.

3.5 INSTALLATION-EXPOSED PIPING

A. Piping Runs:
   1. Parallel to building or column lines and perpendicular to floor, unless shown otherwise.
   2. Piping upstream and downstream of flow measuring devices shall provide straight lengths as required for accurate flow measurement.

B. Supports: As specified in Section 22 05 29, PROCESS SUPPORTS AND ANCHORS.

C. Group piping wherever practical at common elevations; installing to conserve building space and not interfere with use of space and other work.

D. Unions or Flanges: Provide at each piping connection to equipment or instrumentation on equipment side of each block valve to facilitate installation and removal.

E. Install piping so that no load or movement in excess of that stipulated by equipment Manufacturer will be imposed upon equipment connection; install to allow for contraction and expansion without stressing pipe, joints, or connected equipment.

F. Piping clearance, unless otherwise shown:
   1. Over Walkway and Stairs: Minimum of 7’ 6”, measured from walking surface or stair tread to lowest extremity of piping system including flanges, valve bodies or mechanisms, insulation, or hanger/support systems.
   2. Between Equipment or Equipment Piping and Adjacent Piping: Minimum 3’ 0”, measured from equipment extremity and extremity of piping system including flanges, valve bodies or mechanisms, insulation, or hanger/support systems.
   3. From Adjacent Work: Minimum 1” from nearest extremity of completed piping system including flanges, valve bodies or mechanisms, insulation, or hanger/support systems.
   4. Do not route piping in front of or to interfere with access ways, ladders, stairs, platforms, walkways, openings, doors, or windows.
   5. Head room in front of openings, doors, and windows shall not be less than the top of the opening.
   6. Do not install piping containing liquids or liquid vapors in transformer vaults or electrical equipment rooms.
   7. Do not route piping over, around, in front of, in back of, or below electrical equipment including controls, panels, switches, terminals, boxes, or other similar electrical work.
3.6 INSTALLATION-BURIED PIPE

A. Joints:
   1. Dissimilar Buried Pipes:
      a. Provide flexible mechanical compression joints for pressure pipe.
      b. Provide concrete closure collar for gravity and low pressure (maximum 10 psi) piping or as shown.
   2. Concrete Encased or Embedded Pipe: Do not encase joints in concrete unless specifically shown.

B. Placement:
   1. Keep trench dry until pipe laying and joining are completed.
   2. Pipe Base and Pipe Zone: As specified in Section 31 23 23.16, TRENCH BACKFILL.
   3. Exercise care when lowering pipe into trench to prevent twisting or damage to pipe.
   4. Measure for grade at pipe invert, not at top of pipe.
   5. Excavate trench bottom and sides of ample dimensions to permit visual inspection and testing of entire flange, valve, or connection.
   6. Prevent foreign material from entering pipe during placement.
   7. Close and block open end of last pipe section laid when placement operations are not in progress and at close of day’s work.
   8. Lay pipe upgrade with bell ends pointing in the direction the pipe is laying.
   9. Install closure sections and adapters for gravity piping at locations where pipe laying changes direction.
  10. Deflect pipe at joints for pipelines laid on a curve using unsymmetrical closure of spigot into bell. If joint deflection of standard pipe lengths will not accommodate horizontal or vertical curves in alignment, provide:
         a. Shorter pipe lengths.
         b. Special mitered joints.
         c. Standard or special fabricated bends.
  11. After joint has been made, check pipe alignment and grade.
  12. Place sufficient pipe zone material to secure pipe from movement before next joint is installed.
  13. Prevent uplift and floating of pipe prior to backfilling.

C. PVC and CPVC Pipe Placement:
   1. Lay pipe snaking from one side of trench to other.
   2. Offset: As recommended by Manufacturer for maximum temperature variation between time of solvent welding and during operation.
   3. Do not lay pipe when temperature is below 40 °F, or above 90 °F when exposed to direct sunlight.
   4. Shield ends to be joined from direct sunlight prior to and during the laying operation.

D. Tolerances:
   1. Deflection from Horizontal Line, Except PVC, CPVC, or HDPE: Maximum 2”.
   2. Deflection from Vertical Grade: Maximum 1/4”.
   3. Joint Deflection: Maximum of 75% of Manufacturer’s recommendation.
   4. Horizontal position of pipe centerline on alignment around curves maximum variation of 1.75’ from position shown.
   5. Pipe Cover: Minimum 5’, unless otherwise shown.

3.7 THRUST RESTRAINT

A. Location:
   1. Buried Piping: At pipeline tees, plugs, caps, bends, and other locations where unbalanced forces exist.
   2. Exposed Piping: At all joints in pressure piping.
B. Thrust Ties:
   1. Install as detailed.
   2. Anchoring retainer glands or thrust ties with setscrews is unacceptable.

C. Mechanical Joint Valve Restraint in Proprietary Restrained Joint Piping: Install pipe joint Manufacturer’s adapter gland follower and pipe end retainer or thrust tie-rods and socket clamps.

D. Thrust Blocking:
   1. Place between undisturbed ground and fitting to be anchored.
   2. Quantity of Concrete: Sufficient to cover bearing area on pipe and provide required soil bearing area as shown.
   3. Place blocking so that pipe and fitting joints will be accessible for repairs.
   4. Place concrete in accordance with Section 03 30 00, CAST-IN-PLACE CONCRETE.

3.8 BRANCH CONNECTIONS

A. Do not install branch connections smaller than 1/2-inch nominal pipe size, including instrument connections, unless shown otherwise.

B. When line of lower pressure connects to a line of higher pressure, requirements of Piping Data Sheet for higher pressure rating prevails up to and including the first block valve in the line carrying the lower pressure, unless otherwise shown.

C. Threaded Pipe Tap Connections:
   1. Ductile Iron Piping: Connect only with service saddle or at a tapping boss of a fitting, valve body, or equipment casting.
   2. Welded Steel or Alloy Piping: Connect only with welded thread-o-let or half-coupling as specified on Piping Data Sheet.
   3. Limitations: Threaded taps in pipe barrel are unacceptable.

3.9 VENTS AND DRAINS

A. Vents and drains at high and low points in piping required for completed system may or may not be shown. Install the vents on high points, and drains on low points of pipelines, whether shown or not.

3.10 CLEANING

A. Following assembly and testing, and prior to disinfection and final acceptance, flush pipelines (except as stated below) with water at 2.5 fps minimum flushing velocity until foreign matter is removed.

B. Blow clean of loose debris plant process air, natural gas, and instrument air-lines with compressed air at 4,000 fpm; do not flush with water.

C. If impractical to flush large diameter pipe at 2.5 fps or blow at 4,000 fpm velocity, clean in-place from inside by brushing and sweeping, then flush or blow line at lower velocity.

D. Insert cone strainers in flushing connections to attached equipment and leave in-place until cleaning is complete.

E. Remove accumulated debris through drains 2” and larger or by removing spools and valves from piping.
3.11 DISINFECTION
A. Disinfect pipelines intended to carry potable water (W1).
B. See Section 33 13 00, DISINFECTION OF WATER SYSTEMS.

3.12 FIELD FINISHING
A. Notify Engineer at least 3 days prior to start of any surface preparation or coating application work.
B. As specified in Section 09 90 00, PAINTING AND PROTECTIVE COATINGS.

3.13 PIPE IDENTIFICATION
A. See Section 22 05 53, MECHANICAL IDENTIFICATION and 09 90 00, PAINTING AND PROTECTIVE COATINGS.

3.14 INSULATION
A. See Section 40 42 00, PROCESS MECHANICAL INSULATION.

3.15 HEAT TRACING
A. See Section 40 41 13, HEAT TRACING.

3.16 FIELD QUALITY CONTROL
A. Pressure Leakage Testing: As specified. See Section 33 11 11, PIPING LEAKAGE TESTING.
B. Minimum Duties of Welding Inspector:
   1. Job material verification and storage
   2. Qualifications of welders.
   3. Certify conformance with approved welding procedures.
   4. Maintenance of records and preparation of reports in a timely manner.
   5. Notification to Engineer of unsatisfactory weld performance within 24 hours of weld test failure.
C. Required Weld Examinations:
   2. Perform examinations for every pipe thickness and for each welding procedure, progressively, for all piping covered by this section.
   3. Examine at least one of each type and position of weld made by each welder or welder operator.
   4. For each weld found to be defective under the acceptable standards or limitations on imperfections contained in the applicable Piping Code, examine two additional welds made by the same welder that produced the defective weld. Such additional examinations are in addition to the minimum required above 3. Examine, progressively, two additional welds for each tracer examination found to be unsatisfactory.

3.17 SUPPLEMENTS
A. The supplements listed below, following “END OF SECTION,” are a part of this Specification.
   1. Piping Schedule.
   2. Data Sheets.
<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>40 23 39.13</td>
<td>Cement Mortar Lined Ductile Iron Pipe and Fittings</td>
</tr>
<tr>
<td>40 23 39.43</td>
<td>Polyvinyl Chloride (PVC) Pipe and Fittings</td>
</tr>
<tr>
<td>40 23 39.46</td>
<td>Chlorinated Polyvinyl Chloride (CPVC) Pipe and Fittings</td>
</tr>
<tr>
<td>40 23 39.53</td>
<td>Copper and Copper Alloy Pipe, Tubing, and Fittings</td>
</tr>
<tr>
<td>Service</td>
<td>Flow Stream Identifier</td>
</tr>
<tr>
<td>---------------------------------</td>
<td>------------------------</td>
</tr>
<tr>
<td>DECANT</td>
<td>DEC</td>
</tr>
<tr>
<td>GRIT SLURRY</td>
<td>GS or GRIT</td>
</tr>
<tr>
<td>MIXED LIQUOR SUSPENDED SOLIDS</td>
<td>MLSS</td>
</tr>
<tr>
<td>PLANT DRAIN</td>
<td>PD</td>
</tr>
<tr>
<td>PLANT DRAIN</td>
<td>PD</td>
</tr>
<tr>
<td>RETURN ACTIVATED SLUDGE/WASTE</td>
<td>RAS/WAS</td>
</tr>
<tr>
<td>ACTIVATED SLUDGE</td>
<td>RAS</td>
</tr>
<tr>
<td>RETURN ACTIVATED SLUDGE</td>
<td>RAS</td>
</tr>
<tr>
<td>RAW SEWAGE</td>
<td>RS</td>
</tr>
<tr>
<td>SCUM</td>
<td>SCUM</td>
</tr>
<tr>
<td>SECONDARY EFFLUENT</td>
<td>SE</td>
</tr>
<tr>
<td>WASTE ACTIVATED SLUDGE</td>
<td>WAS</td>
</tr>
<tr>
<td>WASTE ACTIVATED SLUDGE</td>
<td>WAS</td>
</tr>
</tbody>
</table>
## PROCESS PIPING SCHEDULE

<table>
<thead>
<tr>
<th>Service</th>
<th>Flow Stream Identifier</th>
<th>Installation (Note 1)</th>
<th>Nominal Diameter (Note 2)</th>
<th>Material (Note 3)</th>
<th>Coating (Note 5)</th>
<th>Spec / Data Sheet No.</th>
<th>Max Operating Temp (°F)</th>
<th>Max Operating Pressure (psig)</th>
<th>Test Pressure (psig) &amp; Method (Note 4)</th>
<th>Pipe Color (Note 5)</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>NON-POTABLE WATER W2</td>
<td>Buried</td>
<td>ALL</td>
<td>PVC or HDPE</td>
<td>40 23 39.43 or 40 23 39.56</td>
<td>Ambient</td>
<td>125</td>
<td>200,H</td>
<td>Purple</td>
<td>1</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Notes:
1. Encased – All buried piping under concrete slabs and/or structures shall be concrete encased per standard detail D40/2400-009 unless indicated otherwise on the Drawings. Exposed – Inside/Outside Submerged – Below Liquid Surface Buried – Directly into Soil
2. > Greater Than
   < Less Than
   <= Less Than or Equal To
   >= Greater Than or Equal To
3. BS – Black Steel
   CELDI – Ceramic Epoxy Lined Ductile Iron
   CLDI – Cement Lined Ductile Iron
   CPVC - Chlorinated Polyvinyl Chloride
   GLDI – Glass Lined Ductile Iron
   CU – Copper
   DWV – Drain Waste Vent
   HDPE – High Density Polyethylene
   MDPE – Medium Density Polyethylene
   STL – Carbon Steel
   SST – Stainless Steel
   FL PVC – Flanged Polyvinyl Chloride Pipe
   PO PVC – Push on Joint Polyvinyl Chloride Pipe
   SW PVC – Solvent Weld Polyvinyl Chloride Pipe
   CLSTL – Cement Lined Welded Steel
   VISS – Vacuum Insulated Stainless Steel

### Remarks:
1. Heat trace and insulate all outside piping
2. Encased RAS/WAS under Clarifier No 5 shall be Ceramic Epoxy Lined Welded Steel.

END OF SECTION
### SECTION 40 23 39.13
**DUCTILE IRON PIPE AND FITTINGS**

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
</tr>
</thead>
</table>
| **Pipe** | **Buried Liquid Service:** Push-On, Mechanical, or Proprietary Restrained Joints: AWWA C110/A21.10-93, AWWA C115/A21.15-88, and AWWA C151/A21.51-91, pressure class conforming to Tables 51.1 and 51.3 for Type 4 trench, 250 psi minimum working pressure.  
**Exposed Pipe:** Grooved End or Flange Joints: AWWA C115/A21.15-88, and AWWA C151/A21.51-91, thickness Class 53 minimum conforming to Table 51.7, 250 psi minimum working pressure. |
| **Coating** | **Buried Pipe:** Exterior coating used under normal conditions shall be an asphaltic coating approximately 1 mil (25 µm) thick and per AWWA C151/A21.51-17.  
**Exposed Pipe:** Shall be as indicated in the schedule. |
| **Encasement** | Polyethylene encasement shall be used on all underground ductile iron pipe, fittings, valves, and appurtenances. See Specification Section 40 42 13.16 – POLYETHYLENE ENCASEMENT FOR DUCTILE IRON AND CAST IRON PIPE. |
| **Lining** | Lining shall be Cement-Mortar AWWA C104/A21.4-90 unless noted otherwise. Ceramic Epoxy Protecto 401 or equal shall be used where indicated in the pipe schedule. Glass Lining; VITCO Corp. SG-14 or equal shall be used where indicated in the schedule. Linings for fittings shall be as indicated below. |
**Mechanical:** 250 psi minimum working pressure, AWWA C111. American Cast Iron Pipe Co., Mechanical Joint; U.S. Pipe and Foundry, Mechanical Joint.  
**Proprietary Restrained:** 150 psi minimum working pressure. Clow Corp., Super-Lock; American Cast Iron Pipe Co., Flex-Ring or Lok-Ring; U.S. Pipe, TR Flex.  
**Grooved End:** Rigid type radius cut conforming to AWWA C606-87, 250 psi minimum working pressure. Victaulic; Gustin-Bacon.  
**Flange:** 125-pound flat face, 250-pound raised face, ductile iron, threaded conforming to AWWA C115/A21-15.88. Gray cast iron will not be allowed. |
## SECTION 40 23 39.13
**DUCTILE IRON PIPE AND FITTINGS**

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Couplings</td>
<td>Grooved End: 250 psi minimum working pressure, malleable iron per ASTM A47-90 or ductile iron per ASTM A536-84. Victaulic; Gustin-Bacon. Grooved End Adapter Flanges: 250-pound malleable iron per ASTM A47-90 or ductile iron per ASTM A536-84. Victaulic; Gustin-Bacon.</td>
</tr>
<tr>
<td>Bolting</td>
<td><strong>Mechanical, Proprietary Restrained, and Grooved End Joints:</strong> 316 Stainless Steel Hardware. <strong>125-pound Flat-Faced Flange:</strong> Exposed piping - ASTM A307-94, Grade A carbon steel hex head bolts and ASTM A563-93, Grade A steel hex head nuts. <strong>250-pound Raised-Face Flange:</strong> Exposed piping - ASTM A307-94, Grade B carbon steel hex head bolts and ASTM A563-93, Grade A carbon steel heavy hex head nuts. All hardware on submerged piping or piping below the top elevation of tanks and directly exposed to water, wastewater and/or wastewater solids, including but not limited to bolts, nuts, washers, and threaded rod shall be stainless steel.</td>
</tr>
</tbody>
</table>
### SECTION 40 23 39.13
### DUCTILE IRON PIPE AND FITTINGS

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
</tr>
</thead>
</table>
| Gaskets                   | **Mechanical, and Proprietary Restrained Joints, Water and Sewage:** Rubber conforming to ANSI/AWWA C111/A21.11-90  
Locking gaskets produced in accordance with AWWA C111 are acceptable for use as a joint restraint mechanism for buried push-on type joints. Locking gaskets shall be rated for the same working pressure as the pipe. American Cast Iron Pipe Co., Fast-Grip Gasket; US Pipe, Field LOK Gaskets.  
**Mechanical and Proprietary Restrained Joints, Air:** Viton, Fluorel, or Manufacturer's standard for high temperature air service, rated to 300 degrees F minimum, conforming to ANSI/AWWA C111/A21.11-90  
**Grooved End Joints:** Halogenated butyl conforming to ASTM D2000-90 and AWWA C606-87. Gaskets for air service shall be pressure-responsive synthetic rubber, rated to 300 degrees F minimum, conforming to ASTM D2000.  
**Flanged, Water and Sewage Services:** 1/8-inch thick, unless otherwise specified, homogenous black rubber (EPDM), hardness 60 (Shore A), rated to 212 degrees F., conforming to ANSI B16.21 and ASTM D1330 Steam Grade.  
**Flanged, Air Service:** 1/8-inch thick, unless otherwise specified, Teflon, PTFE, or compressed inorganic fiber with nitrile binder, rated to 300 degrees F. minimum, conforming to ANSI B16.21 and ASTM D1330.  
Ring gaskets shall not be permitted.  
Blind flanges shall be gasketed covering the entire inside face with the gasket cemented to the blind flange.  
Gasket pressure rating equal to the pressure rating as the pipe or fitting. |
| Joint Lubricant            | Manufacturer’s Standard.                                                                                                                                 |

**END OF SECTION**
### SECTION 40 23 39.43
POLYVINYL CHLORIDE (PVC) PIPE AND FITTINGS

<table>
<thead>
<tr>
<th>Item</th>
<th>Size</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pipe</td>
<td>All</td>
<td>Schedule 80 PVC: Type I, Grade I or Class 23447-B conforming to ASTM D1785-05. Threaded Nipples: Schedule 80 PVC.</td>
</tr>
<tr>
<td>Fittings</td>
<td>All</td>
<td>Schedule 80 PVC as specified above: Conforming to the requirements of ASTM D2467.</td>
</tr>
<tr>
<td>Joints</td>
<td>All</td>
<td>Solvent socket-weld except where connection to valves and equipment may require future disassembly. Threaded joints shall not be used unless specifically approved by Engineer.</td>
</tr>
<tr>
<td>Flanges</td>
<td>All</td>
<td>One piece, molded hub type PVC flat face flange in accordance with Fittings above, 125-pound ANSI B16.1-89 drilling.</td>
</tr>
<tr>
<td>Bolting</td>
<td>All</td>
<td>Flat Face Mating Flange or In Corrosive Areas: ASTM A193/A193M Rev A-94 Type 316 stainless steel Grade B8M hex head bolts and ASTM A194/A194M-94 Grade 8M hex head nuts. With Raised Face Mating Flange: Carbon steel ASTM A307-94 Grade B square head bolts and ASTM A563-93 Grade A heavy hex head nuts.</td>
</tr>
<tr>
<td>Gaskets</td>
<td>All</td>
<td>Flat Face Mating Flange: Full faced 1/8” thick. Raised Face Mating Flange: Flat ring 1/8” thick, with filler gasket between OD of raised face and flange OD to protect the flange from bolting moment. Gasket material shall be suitable for each service. Submit recommended gasket material for each service to Engineer.</td>
</tr>
<tr>
<td>Solvent Cement</td>
<td>All</td>
<td>As recommended by the pipe and fitting manufacturer conforming to ASTM F493 Rev A. Solvent cement shall be rated for use with each service. Provide manufacturer’s certification that the solvent is appropriate for respective service.</td>
</tr>
<tr>
<td>Thread Lubricant</td>
<td>All</td>
<td>Teflon Tape</td>
</tr>
</tbody>
</table>

END OF SECTION
### CHLORINATED POLYVINYL CHLORIDE (CPVC) PIPE AND FITTINGS

<table>
<thead>
<tr>
<th>Item</th>
<th>Size</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Pipe</strong></td>
<td>All</td>
<td>Schedule 80 CPVC: Type IV, Grade I or Class 23447-B conforming to ASTM D1784 and ASTM DF441. Threaded Nipples: Schedule 80 PVC.</td>
</tr>
<tr>
<td><strong>Fittings</strong></td>
<td>All</td>
<td>Schedule 80 CPVC as specified above: Conforming to the requirements of ASTM F439 Rev A for socket-weld type and ASTM F437 for threaded type</td>
</tr>
<tr>
<td><strong>Joints</strong></td>
<td>All</td>
<td>Solvent socket-weld except where connection to valves and equipment may require future disassembly. Threaded joints shall not be used unless specifically approved by Engineer</td>
</tr>
<tr>
<td><strong>Flanges</strong></td>
<td>All</td>
<td>One piece, molded hub type CPVC flat face flange in accordance with Fittings above, 125-pound ANSI B16.1-89 drilling.</td>
</tr>
<tr>
<td><strong>Bolting</strong></td>
<td>All</td>
<td>Flat Face Mating Flange or In Corrosive Areas: ASTM A193/A193M Rev A-94 Type 316 stainless steel Grade B8M hex head bolts and ASTM A194/A194M-94 Grade 8M hex head nuts.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>With Raised Face Mating Flange: Carbon steel ASTM A307-94 Grade B square head bolts and ASTM A563-93 Grade A heavy hex head nuts.</td>
</tr>
<tr>
<td><strong>Gaskets</strong></td>
<td>All</td>
<td>Flat Face Mating Flange: ‘Full faced 1/8” thick.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Raised Face Mating Flange: Flat ring 1/8” thick, with filler gasket between OD of raised face and flange OD to protect the flange from bolting moment. Gasket material shall be suitable for each service. Submit recommended gasket material for each service to Engineer.</td>
</tr>
<tr>
<td><strong>Solvent Cement</strong></td>
<td>All</td>
<td>As recommended by the pipe and fitting manufacturer conforming to ASTM F493 Rev A.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Solvent cement shall be rated for use with each service. Provide manufacturer’s certification that the solvent is appropriate for respective service.</td>
</tr>
<tr>
<td><strong>Thread Lubricant</strong></td>
<td>All</td>
<td>Teflon Tape</td>
</tr>
</tbody>
</table>
## SECTION 40 23 39.53
COPPER AND COPPER ALLOY PIPE, TUBING, AND FITTINGS

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
</tr>
</thead>
</table>
| Tubing     | Seamless, conforming to ASTM B88 Rev A as follows:  
  Buried……………………. Type K, soft or hard temper  
  Exposed…………………….. Type L, hard drawn  
  P-trap priming service……. Type L, soft temper |
| Fittings   | Commercially pure wrought copper, socket joint, conforming to ASTM B75, dimensions conforming to ANSI B16.22.                                     |
| Flanges    | Commercially pure wrought copper, socket joint, conforming to ASTM B75, faced and drilled 150-pound ANSI B16.24 standard.                           |
| Bolting    | ASTM A307, carbon steel, Grade A hex head bolts and ASTM A563 Grade A hex head nuts.                                                         |
| Gaskets    | Flanged, Water and Air Services: 1/16-inch thick, compressed inorganic fiber with nitrile binder, rated to 700 degrees F and 1,000 psi. Ring gaskets shall not be permitted. Blind flanges shall be gasketed covering the entire inside face with the gasket cemented to the blind flange. |
| Solder     | 95-5 wire solder (95 percent tin, 5 percent antimony), conforming to ASTM B32 Grade 95TA. Do not use cored solder.                                      |

END OF SECTION
SECTION 40 23 43 - PROCESS VALVES

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes: Basic requirements for Process Valves.

B. Related sections:
   1. Section 01 33 00 – Submittal Procedures.
   2. Section 01 60 00 – Product Requirements.
   3. Section 01 78 23 – Operation and Maintenance Data.
   4. Section 01 79 00 – Demonstration and Training.
   5. Section 09 90 00 – Painting and Protective Coatings.
   6. Section 22 05 53 – Mechanical Identification.
   8. Section 40 92 13 – Motorized Operators.

1.2 OWNER FURNISHED MATERIALS

A. Owner has pre-purchased portions of the valve systems to be provided to the Contractor for installation. The detailed scope of supply for Owner furnished items is provided in the designated volume of the project documents. The Contractor shall carefully review the scope of supply to determine those items required by the Contract Documents which are not part of the proposal or specified manufacturer’s scope of supply. Costs for installation of Owner furnished materials shall be included in the relevant Lump Sum Bid Price items of the bid form and shall include costs for the following:
   1. All items not specifically itemized in the Owner’s scope of supply but required by the Contract Documents and/or necessary to provide a complete and operational system.
   2. All items specifically itemized in the Owner’s scope of supply which are designated to be provided by others, provided by the customer, or any similar designation.
   3. All labor, materials, and all other associated costs not included in the Scope of Supply but required by the Contract Documents and required to provide a complete and operational system.

1.3 GENERAL

A. See Section 40 23 39, PROCESS PIPING - GENERAL, which contains information and requirements that apply to the work specified herein and are mandatory for this project.

B. Certain valves are specified in Division 44 to be furnished by equipment manufacturer as part of their equipment package and/or system. These valves are to be installed by the Contractor as specified herein. In addition to installation, the Contractor shall be responsible for test, inspection, and assisting the equipment suppliers in start-up services as required to the place the valves into continuous, reliable operation.

1.4 SUBMITTALS

A. Submittals shall be made as required in Section 01 33 00, SUBMITTALS. The following specific information shall be provided:
   1. Shop Drawings:
      a. Product data sheets for make and model.
      b. Complete catalog information, descriptive literature, specifications, and identification of materials of construction.
c. Refer to specific valve type for additional submittal requirements.

2. Quality Control Submittals:
   a. Tests and inspection data.
   b. Manufacturer’s Certificate of Proper Installation.
   c. Manufacturer’s printed installation instructions.
   d. Special shipping, storage and protection, and handling instructions.
   e. Suggested spare parts list to maintain the equipment in service for a period of 5 years. Include a list of special tools required for checking, testing, parts replacement, and maintenance with current price information.
   f. List special tools, materials, and supplies furnished with equipment for use prior to and during startup and for future maintenance.

1.5 OPERATION AND MAINTENANCE DATA

A. O&M Manuals: Content, format, and schedule for providing as specified in Section 01 78 23, OPERATION AND MAINTENANCE DATA.

B. Maintenance Summary Forms: As specified in Section 01 78 23, OPERATION AND MAINTENANCE DATA.

PART 2 - PRODUCTS

2.1 GENERAL

A. Valve to include operator, actuator, hand wheel, chain wheel, extension stern, floor stand, worm and gear operator, operating nut, chain, wrench, and accessories for a complete operation. For operator specifications, see sections 40 92 13 MOTORIZED OPERATORS, and 40 92 16 VALVE AND GATE OPERATORS.

B. Valve shall be suitable for intended service. Renewable parts not to be of a lower quality than specified.

C. Valve shall be the same size as adjoining pipe.

D. Valve ends to suit adjacent piping.

E. Valve shall open by turning counterclockwise unless otherwise specified.

F. Operator, actuator, and accessories shall be factory mounted.

G. EFFECTIVE JANUARY 4, 2014 ANY VALVE, PIPE, FITTING, SOLDER, OR FLUX USED OR IN CONTACT WITH POTABLE WATER MUST COMPLY WITH THE REDUCTION OF LEAD IN DRINKING WATER ACT, AN AMENDMENT TO SECTION 1417 OF THE SAFE DRINKING WATER ACT (SDWA). VALVES SPECIFIED IN THIS SECTION MAY NOT MEET REQUIREMENTS OF THIS ACT, HOWEVER THIS DOES NOT RELIEVE THE CONTRACTOR FROM PROVIDING A VALVE TO MEET REQUIREMENTS OF THE (SDWA) AND THE SAME FUNCTIONAL REQUIREMENTS OF THIS SPECIFICATION.

2.2 SCHEDULE

A. Requirements relative to this section for certain type of actuated or process valves are shown on the Valve Schedules attached as Supplements to the related Sections.
2.3 MATERIALS

A. Brass and bronze valve components and accessories that have surfaces in contact with water shall be alloys containing less than 16% zinc and 2% aluminum.

B. Approved alloys are of the following ASTM designations:
   1. B61, B62, B98 (Alloy UNS No. C65100, C65500, or C66100), B139 (Alloy UNS No. C51000), B584 (Alloy UNS No. C90300 or C94700), B164, B194, and B127.
   2. Stainless steel, AISI Type 316 may be substituted for bronze.

2.4 FACTORY FINISHING

A. Epoxy Lining and Coating:
   1. In accordance with AWWA C550 unless otherwise specified. Coating shall be either two-part liquid material or heat-activated (fusion) material except only heat-activated material if specified as “fusion” or “fusion bonded” epoxy.
   2. Minimum 7-mil dry film thickness except where limited by valve operating tolerances.

B. Exposed Valves Field Finish:
   1. Final paint coating shall be in accordance with Section 09 90 00, PAINTING AND PROTECTIVE COATINGS. System and color shall match adjacent piping system.
   2. Safety isolation valves and lockout valves with handles, hand wheels, or chain wheels “safety yellow.”

2.5 VALVES

A. Gate Valves:
   1. Type V140: Gate Valve, Less Than 3 Inches
      a. General:
         1) Service: Aboveground, clean water and air.
         2) 150 psi Class
         3) Rising Stem type
         4) Threaded ends
         5) Conform to MSS-SP-80, Type 2
      b. Materials:
         1) Body & bonnet: Bronze, ASTM B62 alloy C83600
         2) Disc: Bronze, ASTM B62 alloy C83600
         3) Stem: ASTM B505 alloy C83600 or ASTM B371 alloy C69400
      c. Manufacturers and Products:
         1) Crane – Figure 431.
         2) Jenkins – Figure 2810J
         3) Nibco – T-131
   2. Type V141: Buried Gate Valve, 3 Inches and Larger
      a. Valve shall be resilient wedge type, of non-rising stem design and rated for 250 psig cold water working pressure.
      b. Valve shall meet or exceed all requirements of the latest revision of AWWA C515.
      c. Valve shall have mechanical joint ends, except tapping valves may be flanged by mechanical joint.
      d. Stem shall be sealed by three O-Rings. O-Rings set in a cartridge shall not be allowed.
      e. Each valve shall have maker’s name, pressure rating, and year in which it was manufactured cast in the body. Country of origin to be clearly cast into body & cover castings.
      f. Valves 14” and larger shall be equipped with geared actuators. Valves to be installed in the standard vertical position shall have spur gear actuators. Valve to be installed
in the horizontal position shall have bevel gear actuators. Valves shall only be installed in the horizontal position if noted on the plans or if instructed by the Engineer.

g. Materials:
   1) All cast ferrous components shall be ductile iron, ASTM A536.
   2) The body, bonnet and O-ring plate shall be fusion-bonded epoxy coated, both interior and exterior on body and bonnet. Epoxy shall be applied in accordance with AWWA C550 and be NSF 61 Certified.
   3) Wedge shall be ductile iron fully encapsulated in EPDM rubber.
   4) Hardware shall be 304 stainless steel
   5) Stems shall be cast copper alloy with integral collars in full compliance with AWWA. All stems shall operate with copper alloy stem nuts independent of wedge and of stem
   6) Provide standard AWWA 2-inch operating nut, matching valve key, and valve box for operating stem.

h. Manufacturers and Products:
   1) M&H/Kennedy Valve Company.
   2) Mueller.
   3) American.
   4) Crispin-Ludlow Valve.

3. Type V142: Exposed Gate Valve, 3 Inches and Larger
   a. Valve shall be resilient wedge type, of non-rising stem design and rated for 250 psig cold water working pressure.
   b. Valve shall meet or exceed all requirements of the latest revision of AWWA C515.
   c. Valve shall have flanged ends.
   d. Stem shall be sealed by three O-Rings. O-Rings set in a cartridge shall not be allowed.
   e. Each valve shall have maker’s name, pressure rating, and year in which it was manufactured cast in the body. Country of origin to be clearly cast into body & cover castings.
   f. Valves 14” and larger shall be equipped with geared actuators. Valves to be installed in the standard vertical position shall have spur gear actuators. Valve to be installed in the horizontal position shall have bevel gear actuators. Valves shall only be installed in the horizontal position if noted on the plans or if instructed by the Engineer.
   g. Materials:
      1) All cast ferrous components shall be ductile iron, ASTM A536.
      2) The body, bonnet and O-ring plate shall be fusion-bonded epoxy coated, both interior and exterior on body and bonnet. Epoxy shall be applied in accordance with AWWA C550 and be NSF 61 Certified.
      3) Wedge shall be ductile iron fully encapsulated in EPDM rubber.
      4) Hardware shall be 304 stainless steel
      5) Stems shall be cast copper alloy with integral collars in full compliance with AWWA. All stems shall operate with copper alloy stem nuts independent of wedge and of stem
      6) Provide handwheel, chainwheel, 2” nut, or actuator as noted on the drawings or specified in the valve schedule.

h. Manufacturers and Products:
   1) M&H/Kennedy Valve Company.
   2) Mueller.
   3) American.
   4) Crispin-Ludlow Valve.

4. Type V145: Knife Gate Valve, 2 Inches to 36 Inches
a. Suitable for service under pressures equal to and less than 150 pounds per square inch.
b. Full round port, metal seated, raised face design.
c. Flanged wafer design, drilled and tapped to ANSI Class 125/150 standard.
d. Found gate with beveled edge, finish-ground to 32 RMS, maximum, on both sides.
e. Body to incorporate guides and jams to assist in seating.
f. Materials:
   1) Body: Cast or ductile iron or cast steel, with Type 316 stainless steel lining or cast Type 316 stainless steel.
   2) Wetted Components (including gate): Type 316 stainless steel.
   3) Yoke Sleeve: Acid resisting bronze or aluminum bronze.
   4) Packing: PTFE.
g. Outside screw and yoke (OS&Y) with handwheel operator.
h. Manufacturers and Products:
   1) DeZurik.
   2) Fabri Valve.

B. Globe Valves:
1. Type V200: Globe Valve, 3 Inches and Smaller
   a. General:
      1) Service: Aboveground, clean water.
      2) 150 psi Class
      3) Rising Stem type
      4) Union Bonnet
      5) Threaded ends
      6) Conform to MSS-SP-80, Type 2
   b. Materials:
      1) Body & bonnet: Bronze, ASTM B62 alloy C83600
      2) Disc: PTFE
      3) Stem: ASTM B505 alloy C83600 or ASTM B371 alloy C69400
   c. Manufacturers and Products:
      1) Stockham; B-22T, threaded end.
      2) Crane Co.; 7TF, threaded end.
      3) Nibco: T-235-Y

2. Type V201: Angle Pattern Valve, 2 Inches and Smaller
   a. General:
      1) Service: Aboveground, clean water.
      2) 150 psi Class
      3) Rising Stem type
      4) Union Bonnet
      5) Threaded ends
      6) Conform to MSS-SP-80, Type 2
   b. Materials:
      1) Body & bonnet: Bronze, ASTM B62 alloy C83600
      2) Disc: PTFE
      3) Stem: ASTM B505 alloy C83600 or ASTM B371 alloy C69400
   c. Manufacturers and Products:
      1) Stockham; Figure B-222T.
      2) Crane Co.; Cat. No. 17TF.
      3) Nibco: T-335-Y

3. Type V235: Angle Type Hose Bibb Valve
   a. 3/4-inch NPT female inlet, 3/4-inch male hose thread outlet, heavy rough brass body rated 125 psi, lockshield bonnet, removable handle, atmospheric vacuum breaker conforming to ASSE Standard 1011 and IAPMO code.
b. Manufacturers and Products:
   1) Acorn; 8126, surface pipe mount valve, bent nose without flange.
   2) Acorn; 8121, surface mount through wall valve, bent nose with flange.
   3) Acorn; 8131, pipe and pedestal mounted valve located above 6 inches, straightnose.
   4) Acorn; 8136, pedestal mounted valve located lower than 6 inches inverted nose.

4. Type V236: Angle Pattern Hose Valve, 1 Inch Through 3 Inches
   a. All-bronze, screwed ends, inside screw, rising stem, 'IF±. disc, outlet of cast brass NST by NPT, male by male, nipple adapter with hexagonal wrench feature, rated 300 WOG.
   b. Manufacturers and Products:
      1) Stockham; Figure B-222T.
      2) Crane Co.; Cat. No. 17TF.
      3) James Jones Co.: J-300 Series, angle fire hydrant valve with NPT inlet and National Hose thread outlet.
      4) ITT Kennedy; Figure 936, angle fire hydrant valve with NPT inlet and National Hose thread outlet.

C. Ball Valves:
1. Type V300: Metal Body Ball Valve, Less than 6 Inches
   a. General
      1) Type: Non-lubricated and capable of sealing in either flow direction.
      2) End Connections:
         a) Threaded or solder ends for sizes 3-inch and smaller.
         b) Class 150 flanged for sizes larger than 3 inch. Flanges shall conform to ANSI/ASME B16.1 standards.
      3) Stem Packing: Manually adjustable while valve is under pressure.
      4) Shafts: Rigidly connected to the ball by a positive means. The connection shall be designed to transmit torque equivalent to at least 75 percent of the torsional strength of the shaft.
      5) Handles: Stainless steel latch lock handle with vinyl grip and stainless steel nut designed to open and close the valve under operating conditions.
      6) Temperature Limits: Suitable for operation between minus 20 and 350 degrees Fahrenheit.
   b. Materials:
      1) Valves in Copper Lines: Bronze body
      2) Valves in Steel and Ductile Iron Piping: Ductile iron or cast steel bodies.
      3) Ball: Type 304 or 316 stainless steel.
      4) Seats: PTFE.
      5) Stem Seals: TFE or Viton
      6) Bearings: Self-lubricated, corrosion resistant material that will not contaminate potable water.
   c. Manufacturers and Products:
      1) Apollo.
      2) Nibco.
      3) Milwaukee Valve.

2. Type V302: Metal Body Ball Valve, 6 Inches and Larger
   a. General
      1) Type: Non-lubricated and capable of sealing in either flow direction.
      2) Conform to AWWA C 507.
      3) Stem Packing: Manually adjustable while valve is under pressure.
      4) ANSI B16.1, Class 125 flanged ends.
   b. Materials
1) Body: ASTM A48 cast iron and integrally cast bronze bushed trunnions.
2) Ball: Type 304 or Type 316 stainless steel.
3) Seats: TFE.
4) Stem Seals: TFE or Viton.

c. Manually operated ball valves shall have self-locking worm gear type actuator with position indicator. Gearing shall be permanently lubricated. Provide adjustable screws to stop travel at both Open and Closed positions.

d. Manufacturers and Products:
   1) Henry Pratt.
   2) McANNA/MARPAC

3. Type V303 Instrumentation Ball Valves
   a. Brass or stainless steel body ball valve, nylon handle.
   b. Manufacturers and Products:
      1) Swagelok, 40G Series.
      2) Imperial Eastman; Series 200.

4. Type V330 PVC Body Ball Valve
   a. General:
      1) Type: Non-lubricated and capable of sealing in either flow direction.
      2) End Connections: True union; solvent or heat welded to piping.
      3) Operator Handle: Lever.
      4) All ball valves on sodium hypochlorite lines and/or chlorine dioxide lines shall be venting type valves.

   b. Materials
      1) Body: Polyvinyl chloride (PVC).
      2) Ball: Polyvinyl chloride (PVC).
      3) Seats: Teflon (TFE).
      4) O-rings: Viton (FPM).

   c. Manufacturers and Products:
      1) Asahi/America, Inc.
      2) Nibco.

D. Plug Valves:
1. Type V404: Eccentric Plug Valve, 1/2 Inch through 3 Inches
   a. Non-lubricating type rated 175 psig CWP, drip-tight shutoff with pressure from either direction, cast iron body, or stainless steel body where indicated, with threaded NPT full size inlets. Connection shall be hexagonal for a wrench connection. Plug cast iron with round or rectangular port of no less than 80% of connecting pipe area and coated with Buna-N or Hycar, seats nickel, stem bearing self-lubricating stainless steel, stem seal multiple V -rings or V-cups of nitrile rubber, grit seals on stem.

   b. Provide valves with wrench lever manual operator.

   c. Manufacturers and Products:
      1) DeZurik.
      2) Henry Pratt.
      3) Val-Matic.
      4) Crispin Valve

2. Type V405: Eccentric Plug Valve, 4 Inches through 12 Inches
   a. Non-lubricating type rated 175 psig CWP, drip-tight shutoff with pressure from either direction, cast iron body, or stainless steel body where indicated, with flanged ends or grooved ends in accordance with AWWA C606 for rigid joints, mechanical joint ends for buried valve. Plug cast iron with round or rectangular port of no less than 80% of connecting pipe area and coated with Buna-N or Hycar, seats nickel, stem bearing self-lubricating stainless steel, stem seal multiple V -rings or V-cups of nitrile rubber, grit seals on stem.
b. 4” valve with wrench lever manual operator and 6 through 12” valve with totally enclosed, geared, manual operator with hand wheel, 2” nut, or chain wheel.
c. Manufacturers and Products:
   1) DeZurik.
   2) Henry Pratt.
   3) Val-Matic.
   4) Crispin Valve.

3. Type V406: Eccentric Plug Valve, 14 Inches and Larger
   a. Non-lubricating type rated 150 psig CWP, drip-tight shutoff with pressure from either direction, cast iron body with flanged ends or grooved ends in accordance with AWWA C606 for rigid joints, mechanical joint ends for buried valve. Plug cast iron with round or rectangular port of no less than 80% of connecting pipe area and coated with Buna-N or Hycar, seats nickel, stem bearing self-lubricating stainless steel, stem seal multiple V-rings or V-cups of nitrile rubber, grit seals on stem.
b. Provide with totally enclosed, geared, manual operator with hand wheel, 2” nut, or chain wheel.
c. Manufacturers and Products:
   1) DeZurik.
   2) Henry Pratt.
   3) Val-Matic.
   4) Crispin Valve.

E. Butterfly Valves:
1. General: Provide valves designed and manufactured in accordance with AWWA C504, Class 150B or Class 250B, AWWA C516, and the following requirements:
   a. Valve class shall meet the requirements of the connecting line or as indicated in valve schedule or as indicated on the drawings.
b. Suitable for throttling operations and infrequent operation after periods of inactivity.
c. Elastomer seats bonded to body shall have adhesive integrity of bond between seat and body assured by testing with minimum 75-pound pull in accordance with ASTM D429, Method B. Seat may be retained by mechanical means on valves 24-inches and larger. No epoxy attachment method will be allowed.
d. Bubble-tight with rated pressure, or any pressure lower than rated, applied from either side with the valve mounted in any orientation.
e. No travel stops for the disc on interior of the body.
f. Shaft seal shall include V-type packing for self-adjusting and wear compensation.
g. Isolate metal-to-metal thrust bearing surfaces from flow stream.
h. Valves intended for air service shall meet ANSI B16.104 and ANSI B16.5.

2. Type V500: Butterfly Valve, 4 Inches and Larger
   a. Valve Style: Flanged end, short body type.
b. Flanged end connections shall fully conform with ANSI B16.1 Class 125 or Class 250, or AWWA C207 Class D.
c. Materials:
   1) Body: Class 150B valve bodies shall be ASTM A126, Class B gray iron or ASTM A536 Grade 65-45-12 ductile iron. Class 250B valve bodies shall be ASTM A536 Grade 65-45-12 ductile iron.
   2) Disc: Valve disc shall be made from cast iron ASTM A-126 Class B or stainless steel ASTM A351 in sizes 20” and smaller. Sizes 24” and larger shall be built from ductile iron in conformance to ASTM A-536. Disc shall be furnished with Type 316 stainless steel seating edge to mate with the rubber seat on the body.
   3) Shafts: Shafts shall be Stainless Steel. ASTM A276 Type 304, or Type 316, or ASTM A564, grade 630.
   4) Seat: Valve seat shall be Buna-N rubber located on the valve body. In sizes 20” and smaller, valves shall have bonded seats that meet test procedures
outlined in ASTM D-429 Method B. Sizes 24" and larger shall be retained in the valve body by mechanical means without use of metal retainers or other devices located in the flow stream.

5) Bearings: Shall be sleeve type that is corrosion resistant and self-lubricating.

6) Manual Actuators: Shall be fully grease packed and have stops in the open/close position. The actuator shall have a mechanical stop which will withstand an input torque of 450 ft. lbs. against the stop. The traveling nut shall engage alignment grooves in the housing. The actuators shall have a built in packing leak bypass to eliminate possible packing leakage into the actuator housing.

7) Hardware: All seat retaining hardware shall be Type 316 stainless steel.

d. Manufacturers and Products:
1) Henry Pratt/Mueller
2) DeZurik - AWWA Butterfly Valves (BAW) 150B or 250B
3) Crispin Valve
4) Val-Matic – American BFV 150B or 250B

3. Type V504: Buried Butterfly Valve, 4 Inches and Larger
a. Valve Style: Mechanical joint end type
b. Mechanical joint end connections shall fully conform to ANSI/AWWA C111/A21.11.
c. Valve position indicator at valve box locations. Indicator to be hermetically sealed and show valve disc position, direction of rotation, and number of turns from FULLY OPENED to FULLY CLOSED.

d. Materials:
1) Body: Class 150B valve bodies shall be ASTM A126, Class B gray iron or ASTM A536 Grade 65-45-12 ductile iron. Class 250B valve bodies shall be ASTM A536 Grade 65-45-12 ductile iron.
2) Disc: Valve disc shall also be made from cast iron ASTM A-126 Class B in sizes 20" and smaller. Sizes 24" and larger shall be built from ductile iron in conformance to ASTM A-536. Disc shall be furnished with Type 316 stainless steel seating edge to mate with the rubber seat on the body.
3) Shafts: Shafts shall be Stainless Steel. ASTM A276 Type 304, or Type 316, or ASTM A564, grade 630.
4) Seat: Valve seat shall be Buna-N rubber located on the valve body. In sizes 20" and smaller, valves shall have bonded seats that meet test procedures outlined in ASTM D-429 Method B. Sizes 24" and larger shall be retained in the valve body by mechanical means without use of metal retainers or other devices located in the flow stream. No epoxy attachment method will be allowed.
5) Bearings: Shall be sleeve type that is corrosion resistant and self-lubricating.
6) Manual Actuators: Shall be suitable for buried service. Shall be fully grease packed and have stops in the open/close position. The actuator shall have a mechanical stop which will withstand an input torque of 450 ft. lbs. against the stop. The traveling nut shall engage alignment grooves in the housing. The actuators shall have a built in packing leak bypass to eliminate possible packing leakage into the actuator housing.

7) Hardware: All seat retaining hardware shall be Type 316 stainless steel.

e. Manufacturers and Products:
1) Pratt / Mueller
2) Henry Pratt - Class 150B - Groundhog
3) Class 250B - HP-250II
4) Mueller Co. - Class 150 B - Lineseal III
5) Class 250 B – Lineseal XP
6) DeZurik - AWWA Butterfly Valves (BAW) 150B or 250B
7) Crispin Valve
8) Val-Matic - American BFV 150B or 250B
4. Type V510: Lug Style Butterfly Valve, 2 Inches and Larger  
   a. Cast iron ASTM A126 body, ASTM A351-CF8M discs, Type 18-8 stainless steel or Type 416 stainless steel one-piece stem/shaft, self-lubricating sleeve-type Teflon or bronze bearing, EPDM replaceable resilient seat, self-adjusting multi-ring V-type packing, suitable for temperatures up to 250°F, bubble-tight at 150 psi differential pressure. Flanges and/or mounting design shall be for ANSI B16.1 125- or 150-pound flanges.  
   b. Manufacturers:  
      1) Henry Pratt – Series 397  
      2) DeZurik – BOS-CL  
      3) Bray Valve  
      4) J&S Valve – Series 2300 and 2500

5. Type V511: Wafer-Style Butterfly Valve, 2 Inches and Larger  
   a. Cast iron body, cast iron or ductile iron discs, Type 18-8 stainless steel one-piece stem, self-lubricating sleeve type bearing, EPDM replaceable resilient seat, self-adjusting packing, suitable for temperatures up to 250 degrees F, bubble-tight at 50 psi differential pressure, valve body to fit between ANSI B16.1 flanges.  
   b. Manufacturers:  
      1) Henry Pratt  
      2) DeZurik  
      3) Bray Valve  
      4) J&S Valve – Series 2300 and 2500

6. Type V512: Plastic Body Butterfly Valve, 8 Inches and Smaller  
   a. PVC or CPVC body, CPVC discs, 316 SS stem/shaft, Viton (FKM) seats and seals, suitable for pressures of up to 150 psi at 70°F. The liner seal shall be full seat design such that the disc and seat are the only wetted parts. Flanges and/or mounting design shall be for ANSI B16.5 or ANSI B16.10 bolt patterns  
   b. Manufacturers  
      1) Asahi/America, Inc.

F. Check and Flap Valve:  
   1. Type V600: Check Valve, 2 Inches and Smaller  
      a. All-bronze, screwed ends and cap, swing type replaceable Buna-N disc, rated 125-pound SWP, 200-pound WOG.  
      b. Manufacturers:  
         1) Stockham  
         2) Milwaukee Valve  
         3) Valmatic

   2. Type V605: Resilient Seated Swing Check Valve, 3 Inches and Larger  
      a. Valve Connections: Flanged in accordance with ANSI B16.1, Class 125  
      b. The valve shall be in conformance with AWWA C508  
      c. The valves used in potable water service shall be certified to NSF/ANSI 61 Drinking Water System Components – Health Effects, and certified to be Lead-Free in accordance with NSF/ANSI 372.  
      d. The valve body shall be full flow equal to nominal pipe diameter at all points through the valve. The 4 in. (100mm) valve shall be capable of passing a 3 in. (75mm) solid. The seating surface shall be a minimum of 35 degree angle to minimize disc travel. A threaded port with pipe plug shall be provided on the bottom of the valve to allow for field installation of a backflow actuator or oil cushion device without special tools or removing the valve from the line.  
      e. The top access port shall be full size, allowing removal of the disc without removing the valve from the line. The access cover shall be domed in shape to provide flushing action over the disc for operating in lines containing high solids content. A threaded
port with pipe plug shall be provided in the access cover to allow for field installation of a mechanical, disc position indicator.

f. The disc shall be of one-piece construction, precision molded with an integral O-ring type sealing surface and reinforced with alloy steel. The flex portion of the disc shall have no penetrations, contain nylon reinforcement and shall be warranted for twenty-five years. Non-Slam closing characteristics shall be provided through a short 35 degree disc stroke and a disc accelerator to provide a cracking pressure of 0.3 psig.

g. The disc accelerator shall be of one piece construction and provide rapid closure of the valve in high head applications. The disc accelerator shall be enclosed within the valve and shall be field adjustable and replaceable without removal of the valve from the line. The disc accelerator shall be securely held in place captured between the cover and disc. It shall be formed with a large radius to allow smooth movement over the disc surface.

h. Materials:
1) Body: The valve body and cover shall be constructed of ASTM A536 Grade 65-45-12 ductile iron or ASTM A126 class B gray iron for 30 in. (800mm) and larger. The exterior and interior of the valve shall be coated with an NSF/ANSI 61 approved fusion bonded epoxy coating.
2) Disc: The disc shall be precision molded Buna-N (NBR), ASTM D2000-BG.
3) Hardware: All retaining hardware shall be Type 316 stainless steel.

i. Manufacturers and Products:
1) Val-Matic - Surgebuster
2) Henry Pratt – RD-Series
3) DeZurik/APCO – Series 100
4) Crispin – RF/ASR

3. Type V608: Swing Check Valve, 2 Inches and Larger
a. AWWA C508, flanged end, cast iron body, bronze mounted valve, solid bronze hinges, stainless steel hinge shaft.

b. Valve 2" through 12" rated 175-pound and 14" through 36" rated 150-pound cold water, non-shock. Valve fitted with adjustable outside lever and spring. Increasing-pattern body valve may be used where increased outlet piping size is shown.

c. Manufacturers:
1) Crispin Valve
2) Val-Matic.
3) DeZurik.

4. Type V612: Double Disc Swing Check Valve, 2 Inches and Larger
a. Lug wafer style, spring loaded, cast or ductile iron body, aluminum-bronze or ductile iron doors, resilient seats, stainless steel hinge pin, stop pin spring.

b. Valve 2 inches through 12 inches rated 200-pound cold water and valve 14 inches through 54 inches rated 150-pound cold water.

c. Manufacturers:
1) Crispin Valve.
2) DeZurik.

5. Type V614: Stainless Steel Check Valve, 2 Inches and Smaller
a. Type 316 stainless steel body, disc, cap, and trim. Screwed ends and cap, swing-type disc; Class 150.

b. Manufacturers and Products.
1) Stockham.
2) Or equal.

6. Type V625: Slanting Disc Check Valve, 2 Inches and Larger
a. Two-piece cast iron construction, Body shall be ASTM A126, Grade B cast iron. Disc shall be bronze ASTM B584. Pivot pins and bushing shall be stainless steel. The
valve shall be provided with a bottom mounted hydraulic buffer. The buffer shall contact and control the disc closure rate.

b. Manufacturer:
   1) DeZurik.
   2) Val-Matic.
   3) Crispin Valve.

7. Type V631: CPVC Ball Check Valve, 4 Inches and Smaller
   a. ASTM D1784 Cell Class 23477B chlorinated polyvinyl chloride body, single or dual union socket weld ends, rated 150 psi at 73 °F, 110 psi at 140 °F, Viton seat and seal.
   b. Manufacturers:
      1) Asahi/America, Inc.
      2) Nibco.
      3) Spears.

8. Type V632: CPVC Foot Valve with Strainer, 4 Inches and Smaller
   a. ASTM D1784 Cell Class 23477B chlorinated polyvinyl chloride body, single or dual union socket weld ends, rated 150 psi at 73 °F, 110 psi at 140 °F, CPVC screen, Viton seat and seal.
   b. Manufacturers:
      1) Asahi/America, Inc.
      2) Nibco.
      3) Spears.

9. Type V635: Check Valve for Air Service, 2 Inches and Larger:
   a. Check valves for low pressure process air service shall be carbon steel type with 150# flanged ends, rated 150 psig at 300 °F. Valve shall have stainless steel split disc mounted on Type 316 stainless steel center post, such that wafer type butterfly valve can be mounted directly downstream of check valve when discs of both valves are in the OPEN position.
   b. Manufacturers:
      1) Techno Corporation, Style 5003
      2) Crane, Style H

10. Type V641: Double Check Valve Assembly, 2-1/2 Inches through 10 Inches
    a. General:
       1) Regulatory Compliance: AWWA-C510-92, CSA B64.5, FCCHR of USC Section 10, ASSE 1048, IAPMO (UPC), SBCCI.
       2) Valve Body: Bronze
       5) Temperature Range: 32 Degrees to 140 Degrees Fahrenheit.
    b. Manufacturers:
       1) Febco.
       2) Watts.
       3) Hersey.

11. Type V642: Reduced Pressure Backflow Preventer, 3/4 Inches and Larger
    a. General, (3/4 Inches through 2 Inches):
       1) Regulatory Compliance: AWWA-C510-92, CSA B64.5, FCCHR of USC Section 10, ASSE 1048, IAPMO (UPC), SBCCI.
       2) Valve Body: Bronze
       3) End Connection: Threaded, NPT ANSI/ASME B1.20.1
       5) Temperature Range: 32 Degrees to 140 Degrees Fahrenheit.
6) Shut-off Valves: Full port resilient seated, bronze ball valves with bronze ball valve test cocks.
7) Size(s) and rating(s) as shown in the schedules following this Section.
8) Manufacturers:
   a) Febco.
   b) Watts.

b. General, (2 Inches and Larger):
   1) Regulatory Compliance: AWWA-C510-92, CSA B64.5, FCCHR of USC Section 10, ASSE 1048, IAPMO (UPC), SBCCI.
   2) Valve Body: Ductile or Cast Iron, Class 125
   3) End Connections: Flanged, ANSI B 16.1
   5) Temperature Range: 32 Degrees to 140 Degrees Fahrenheit.
   6) Shut-off Valves: Non-rising stem, resilient seated gate valves with bronze ball valve test cocks.
   7) Accessories: Drain line with air gap.
   8) Size(s) and rating(s) as shown in the schedules following this Section.
   9) Manufacturers:
      a) Febco.
      b) Watts.

12. Type V650: Stainless Steel Flap Valve
   a. General, (4 Inches and 6 Inches):
      1) Valve Body: 316 stainless steel
      2) End Connection: Flanged, 125# ANSI B 16.1
      3) Seat: buna-n seal
      4) Manufacturers:
         a) Troy Valve.
         b) Golden Harvest.

G. Self-Contained Automatic Valves:
1. Type V710: Pressure Regulating Valve, 2-1/2 Inches and Smaller
   a. General:
      1) Maximum Inlet Pressure: 200 psig.
      2) Outlet Pressure Ranges: 20 to 80 psig.
      3) Maximum Allowable Outlet Pressure: 10% above spring setting, or 5 psig above setting, whichever is greater.
      4) Maximum Operating Differential: 5 psi.
      5) Maximum Operating Temperature: -20 Degrees to 150 Degrees Fahrenheit.
   b. Construction Materials:
      1) Body: Bronze.
      2) Spring Case: Cast Iron.
      3) Valve Disk and Holder: Nitrile (NBR) and bronze.
      4) Diaphragm: Nitrile (NBR)
   c. Manufacturers:
      1) Fisher.
      2) Mueller.

2. Type V711: High-Pressure Regulating Valve, 2 Inches and Smaller
   a. General:
      1) Maximum Inlet Pressure: 300 psig.
      2) Outlet Pressure Ranges: 5 to 150 psig.
      3) Maximum Operating Temperature: 150 Degrees Fahrenheit.
   b. Construction Materials:
      1) Body: Stainless Steel.
2) Spring Case: Stainless Steel.
3) Valve Disk and Holder: Nitrile (NBR) and bronze.
4) Diaphragm: Nitrile (NBR)

c. Manufacturers:
   1) Fisher.
   2) Mueller.

3. Type V712: High-Pressure Regulating Valve, 3 Inches and Smaller
   a. General:
      1) Maximum Inlet Pressure: 150 psig.
      2) Outlet Pressure Ranges: 5 to 125 psig.
      3) Maximum Operating Temperature: 140 Degrees Fahrenheit.
   b. Construction Materials:
      1) Body: Machined PVC
      2) Seals: Viton
   c. Manufacturers:
      1) Plast-O-Matic Valves, Inc.

4. Type V713: Pressure Reducing Valve, 1 Inch through 4 Inches
   a. General:
      1) Maximum Inlet Pressure: 250 psig (Cast Iron), 300 psig (Steel).
      2) Droop: 10% of outlet pressure setting.
      3) Maximum Differential Pressure: 150 psig or body rating limit, whichever is lower.
      4) Body: Ductile Iron, Cast Steel, or Bronze.
      5) Disc Retainer and Diaphragm Washer: Cast Iron, Cast Steel, or Bronze.
      6) Stem, Nut and Spring: Stainless Steel
      7) Diaphragm: Nylon Reinforced Buna-N Rubber
   b. Manufacturers:
      1) Cla-Val.
      2) Fisher.
      3) Ross Valve.

5. Type V730: Pressure Relief Valve, 2 Inches and Smaller
   a. Direct diaphragm, spring controlled, Type 316 stainless steel body, spring case, Type 316 stainless steel diaphragm, stainless steel valve stem.
   b. Capable of opening when upstream-pressure reaches a maximum set point.
   c. Manufacturers:
      1) Fisher.
      2) Or equal.

6. Type V731: Pressure Relief Valve, 1/4 Inch through 2 Inches
   a. General:
      1) Maximum Line Pressure: 150 psi
      2) Setting Range: 15-150 psi
   b. Capable of opening when upstream-pressure reaches a maximum set point.
   c. Construction Materials:
      1) Body: PVC, CPVC
      2) Spring Case: PVC
      3) Spring Keepers: PVC
      4) Diaphragm: PVC, PTFE
      5) Orifice Seal: EPDM, FKM
      6) Adjustment Screw: 316 SS
   d. Manufacturers:
      1) Primary Fluid Systems, Inc.
      2) Or equal.
7. Type V732: Pressure Relief Valve, Pressure Sustaining Valve, 1 Inch and Larger
   a. Hydraulically operated, diaphragm, actuated, pilot controlled globe valve, cast iron body, ANSI B16.1 flanged ends, rated 175 psi, stainless steel trim, stainless steel stem, externally mounted strainers with cocks, to open when upstream pressure reaches a maximum set point.
   b. Manufacturers:
      1) Cla-Val.
      2) Or equal.

8. Type V750: Well Service Air Valve, 1/2 Inch and Larger
   a. Fully automatic float operated valve, suitable for vertical turbine pump discharge service, designed to exhaust air which is present in pump column on pump start-up and allow air to re-enter the column on pump shutdown or should a negative pressure occur.
   b. Valves used in potable water service shall be NSI/ANSI 61 certified.
   c. Valves 3” and smaller shall be equipped with a dual port throttling device to provide adjustable control of the exhaust rate and allow free air to flow into the valve through a separate inlet port. Valves 4” larger shall be equipped with a regulated exhaust device, which shall allow free airflow in and out of the valve, close upon rapid air exchange, and control the air exhaust rate to reduce pressure surges.
   d. Valve interiors and exteriors shall be coated with an NSF/ANSI 61 certified fusion bonded epoxy in accordance with AWWA C550.
   e. Connections:
      1) Inlet-Valve sizes 3 in. and smaller shall have full size NPT inlets and outlets equal to the nominal valve size. The body inlet connection shall be hexagonal for a wrench connection. Valve sizes 4 in. and larger shall have bored flange inlets equal to the valve size. Flanges shall be in accordance with ANSI B16.1 for Class 125 or Class 250 iron flanges and ANSI B16.42 for Class 300 ductile iron flanges.
      f. Outlets-Valve sizes 6 in. and smaller shall have NPT outlets; Valves 8 in. and larger shall have ANSI B16.1 Class 125 outlet flanges. The valve shall have two additional NPT connections for the addition of Air Release Valves, gauges, testing, and draining.
      g. Materials: The Well Service Air Valve body, cover, and baffle shall be constructed of ASTM A126 Class B cast iron for Class 125 and Class 250 valves. Class 300 ductile iron valves shall be constructed of ASTM A536 Grade 65-45-12 cast ductile iron. The float, guide shafts, and bushings shall be constructed of Type 316 stainless steel. Non-metallic guides and bushings are not acceptable. Resilient seats shall be Buna-N.
      h. Manufacturers:
         1) Val-Matic.
         2) DeZurik.
         3) Crispin Valve.

9. Type V752: Wastewater Combination Air Valves, 1 Inch and Larger
   a. Valve shall be automatic float operated valve designed to exhaust large quantities of air during the filling of a piping system and close upon liquid entry. The valve shall open during draining or if a negative pressure occurs. The valve shall also release accumulated air from a piping system while the system is in operation and under pressure.
   b. Valve shall perform functions of both air release and Air/Vacuum valves and be furnished as a single body.
   c. Valve shall be suitable for use with domestic sewage.
   d. Valve body and structure shall be constructed of cast iron or ductile iron. Float, guide shafts and bushings shall be stainless steel.
e. Manufacturers:
   1) Val-Matic.
   2) DeZurik.
   3) Crispin Valve.

10. Type V755: Clean Water Combination Air Valve, 1 Inch and Larger
   a. Valve shall be automatic float operated valve designed to exhaust large quantities
      of air during the filling of a piping system and close upon liquid entry. Valve shall
      open during draining or if negative pressures occur. Valve shall also release
      accumulated air from a piping system while system is in operation and under
      pressure.
   b. Valve shall perform functions of both air release and Air/Vacuum valves and be
      furnished as a single body.
   c. Valves used in potable water shall be NSF/ANSI certified.
   d. Valve body and structure shall be constructed of cast iron or ductile iron. Float, guide
      shafts and bushings shall be stainless steel.
   e. Manufacturers:
      1) Val-Matic.
      2) DeZurik.
      3) Crispin Valve.

11. Type V757: Air Release Valve for Water Service, 1/2 Inch and Larger
   a. General:
      1) Valve shall be automatic float operated valve designed to release
         accumulated air from a piping system while system is in operation and under
         pressure.
      2) Comply with AWWA C512.
      3) Furnish blowoff valve, quick-disconnect couplings, and minimum 6 feet of
         hose.
      4) End Connections:
         a) Inlet Valve End Connections Size 1/2 to 3 Inches: NPT.
         b) Inlet Valve End Connections Size 4 Inches and Larger: Flanged. ANSI
            B16.1 for Class 150 and ANSI B16.42 for Class 300.
         c) Outlet Valve End Connections Size 6 Inches and smaller: NPT.
         d) Outlet Valve End Connections Size 8 Inches and Larger: Flanged ANSI
            B16.1
      5) Working Pressure: As indicated in pipe schedule.
      6) Size: As indicated in Drawings.
   b. Materials:
      1) Body and Cover: Cast iron or Ductile iron.
      2) Float, Seat, and Trim: Type 316 stainless steel.
      3) Valve interiors and exteriors shall be coated with an NSF/ANSI 61 certified
         fusion bonded epoxy in accordance with AWWA C550.
   c. Manufacturers:
      1) Val-Matic Valve & Manufacturing Corp.
      2) Dezurik.

12. Type V780: Safety Relief Valve for Air Service, 1-1/2 Inch through 3 Inches
   a. Spring loaded, adjustable pressure relief valve for process air service, with stainless
      steel trim; seat material suitable for elevated temperatures above 300 °F, test pull
      ring or lever.
   b. Manufacturers:
      1) Kunkle.
      2) Apollo Valve.

13. Type V785: Safety Relief Valve for Air Service
a. Exposed spring, full nozzle with stainless steel trim, cast steel body, seat material suitable for elevated temperatures above 300 °F.
b. Manufacturers:
   1) Kunkle.

H. Miscellaneous Valves:
1. Type V901: Diaphragm Valve, 1/2 Inch and Larger
   a. Diaphragm valves shall be weir type with solid CPVC body and bonnet. Provide with Type 316 stainless steel bushing bolts, and other integral metallic components (etc., sleeve and stem). All metallic components shall be isolated for contact with fluid and the surrounding atmosphere. Valves 1/2” through 2” shall have true union socket ends. Valves 2-1/2” and larger shall have ANSI flanged ends. Manual operator shall be indicating, rising stem type with hand wheel. Valve working pressure shall be 100 psig at 120 °F. Valve must also be suitable for testing at elevated pressure per respective flow stream as indicated in Piping Schedule. Diaphragm shall be PTFE or Viton.
   b. Manufacturers:
      1). George Fisher.
      2). Asahi/America, Inc.

2. Type V902: Pinch Valve
   a. Iron body, fanged ends, TFE Teflon sleeves, upper and lower pinch bars, and hand wheel operator.
   b. Manufacturer: 1). Red Valve Co.

3. Type V903: Anti-Siphon/Back Pressure Valves, 2 Inch and Smaller
   a. Spring controlled diaphragm, CPVC body, with a safety vent, to close when upstream pressure reaches a minimum set point and serve as an anti-siphon device. Rated 150 psi. The safety vent shall be connected to a leak containment system which shall include clear polyethylene tubing connecting to a vented, CPVC spill chemical neutralization bucket appropriate for the chemical service.
   b. Construction Materials:
      1) Body: CPVC
      2) Diaphragm: PTFE
   c. Manufacturers:
      1) Plast-O-Matic Valves, Inc.
      2) Or equal.

4. Type V910 Telescoping Valve, 4 Inches through 36 Inch
   a. Valve configuration shall be as shown on the Drawings and detailed within the Supplements following End of Section.
   b. Complete assembly consisting of rising stem, slip tube, seal flange, lifting bail, valve stand with indicator and motor, when required, and Type 316 stainless steel anchor bolts and mounting hardware.
   c. Slip tube shall be Type 304 stainless steel, manufactured from seamless pipe or tube, with a minimum wall thickness of 1/8” and must be of sufficient length to facilitate valve travel and maintain an appropriate insert depth.
   d. A stainless steel companion flange and neoprene slip seal gasket shall be provided. The gasket shall be a minimum 1/4-inch thick, mounted to allow sliding and shall be watertight throughout the travel of the slip tube.
   e. Lift shall be handwheel type and stem shall be of the rising type, stainless steel, thrust bearings, automatic self-locking, and provide infinite valve positioning. A clear plastic Butyrate stem cover shall be provided with a mylar strip type position indicator, calibrated in 1/4-inch increments to illustrate valve position.
   f. Manufacturers and Products:
1) Troy Valve
2) Waterman; TS-2.
3) Golden-Harvest
4) Amwell; Type RP.

5. Type V915: Mud Valve
   a. Cast iron body tapered seat, bronze disc and seat ring, frame flanged, nonrising type stem, bronze extension stem, 2” square operating nut for floor box operation, and stem guides for maximum unsupported stem length of 5 feet.
   b. Manufacturers and Products:
      1) Waterman; MV11.
      2) Clow; F-3075.
      3) Troy Valve; A25600RB

6. Type V916: Mud Valve
   a. Type 316 stainless steel body tapered seat, disc and seat ring, frame flanged, nonrising type stem, stainless steel extension stem, 2” square operating nut for floor box operation, and stem guides for maximum unsupported stem length of 5 feet.
   b. Manufacturers and Products:
      1) Waterman.
      2) Clow.
      3) Troy Valve

7. Type V940 Solenoid Valve, 2 Inches and Smaller
   a. Two-way internal pilot operated diaphragm type, brass body, resilient seat suitable for air or water, solenoid coil molded epoxy, NEMA Class A, 120 volts ac, 60-Hz, unless otherwise indicated. Solenoid enclosure NEMA 250, Type 4 unless otherwise indicated. Size and normal position (OPEN or CLOSED when de-energized) as indicated.
   b. Minimum operating pressure differential no less than 5 psig, maximum operating pressure differential no greater than 125 psig.
   c. Manufacturers and Products:
      1) ASCO
      2) Skinner

8. Type V941 Plastic Body Solenoid Valve, 2 Inches and Smaller
   a. Two-way internal pilot operated diaphragm type, PVC body, resilient seat suitable for air or water, solenoid coil molded epoxy, NEMA 4X, 120 volts ac, 60-Hz, unless otherwise indicated. Solenoid enclosure NEMA 250, Type 4 unless otherwise indicated. Size and normal position (OPEN or CLOSED when de-energized) as indicated.
   b. Minimum operating pressure differential no less than 5 psig, maximum operating pressure differential no greater than 140 psig.
   c. Manufacturers and Products:
      1) Plast-O-Matic Valves, Inc.
      2) Or Equal.

2.6 TAGGING REQUIREMENTS

A. See Section 22 05 53, MECHANICAL IDENTIFICATION.

B. The tags shall be attached to the valves by soldered split key rings so that ring and tag cannot be removed. The tag shall bear the 1/4” die-stamped equipment identification number as indicated in the Contract Documents.
2.7 ACCESSORIES

A. T-Handled Operating Wrench:
   1. 2 each galvanized operating wrenches, 4 feet long.
   2. Manufacturers and Products:
      b. Clow No.; F-2520.
   3. 2 each galvanized operating keys for cross handled valves.

B. Cast Iron Valve Box: Designed for traffic loads, sliding type, with minimum of 6" ID shaft.
   1. Box: Cast iron with minimum depth of 9".
   2. Lid: Cast iron, minimum depth 3", marked for the appropriate service.
   3. Extensions: Cast iron.

PART 3 - EXECUTION

3.1 SHIPPING, STORAGE, HANDLING, AND PROTECTION

A. As specified in Section 01 60 00, PRODUCT REQUIREMENTS.

3.2 INSTALLATION

A. Flange Ends:
   1. Flanged valve bolt holes shall straddle vertical centerline of pipe.
   2. Clean flanged faces, insert gasket and bolts, and tighten nuts progressively and uniformly.

B. Screwed Ends:
   1. Clean threads by wire brushing or swabbing.
   2. Apply joint compound.

C. Valve Orientation:
   1. Install operating stem vertical when valve is installed in horizontal runs of pipe having centerline elevations 4’ 6” or less above finished floor, unless otherwise shown.
   2. Install operating stem horizontal in horizontal runs of pipe having centerline elevations between 4’ 6” and 6’ 9” above finish floor, unless otherwise shown.
   3. Orient butterfly valve shaft so that unbalanced flows or eddies are equally divided to each half of the disc, i.e., shaft is in the plane of rotation of the eddy.
   4. If no plug valve seat position is shown, locate as follows:
      a. Horizontal Flow: The flow shall produce an “unseating” pressure, and the plug shall open into the top half of valve.
      b. Vertical Flow: Install seat in the highest portion of the valve.

D. Install a line size ball valve and union upstream of each solenoid valve, in-line flow switch, or other in-line electrical device, excluding magnetic flow meters, for isolation during maintenance.

E. Install safety isolation valves on compressed air.

F. Locate valve to provide accessibility for control and maintenance. Install access doors in finished walls and plaster ceilings for valve access.

G. Extension Stem for Operator: Where the depth of the valve is such that its centerline is more than 3 feet below grade. Furnish an operating extension stem with 2"operating nut to bring the operating nut to a point 6" below the surface of the ground and/or box cover.
H. Torque Tube: Where operator for quarter-turn valve is located on floor stand. Furnish extension stem torque tube of a type properly sized for maximum torque capacity of the valve.

I. Floor Box and Stem: Steel extension stem length shall locate operating nut in floor box.

3.3 TESTS AND INSPECTION

A. Valve may be either tested while testing pipelines, or as a separate step.

B. Test that valves open and close smoothly with operating pressure on one side and atmospheric pressure on the other, in both directions for two-way valve and applications.

C. Inspect air and vacuum valves as pipe is being filled to verify venting and seating is fully functional.

D. Count and record number of turns to open and close valve; account for any discrepancies with Manufacturer's data.

E. Set, verify, and record set pressures for all relief and regulating valves.

F. Automatic valve to be tested in conjunction with control system testing.

G. Test hydrostatic relief valve seating; record leakage. Adjust and retest to maximum leakage of 0.1 gpm per foot of seat periphery.

3.4 MANUFACTURER'S SERVICES

A. A Manufacturer's representative for the equipment specified herein shall be present at the jobsite for the minimum person-days listed for the services herein under, travel time excluded:
   1. 2 person-days for installation assistance, inspection, and certification of the installation. Provide certificate.
   2. 2 person-days for functional and performance testing.
   3. 2 person-days for pre-startup classroom or jobsite training of Owner'S personnel.

B. Training of Owner'S personnel shall be at such times and at such locations as requested by Owner.

C. See Section 01 79 00, demonstration and training.

3.5 MANUFACTURER'S CERTIFICATE(S)

A. Provide Manufacturer's certificate(s) in accordance with Section 01 79 00.

3.6 SUPPLEMENTS

A. The supplements listed below, following "END OF SECTION," are a part of this Specification.
   1. Power Operated Valve Schedule.
   2. Self-Contained Valve Schedule.

END OF SECTION
### 40 23 43: PROCESS VALVES
#### POWER OPERATED VALVE SCHEDULE

<table>
<thead>
<tr>
<th>TAG NO.</th>
<th>P&amp;ID DRAWING</th>
<th>FLOW STREAM ID</th>
<th>VALVE TYPE (NOTE 1)</th>
<th>OPERATION (NOTE 2)</th>
<th>BODY SIZE (IN)</th>
<th>FAIL ACTION (NOTE 4)</th>
<th>MAX FLOW / MIN FLOW</th>
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<th>MAX/MIN PRESSURE</th>
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### NOTES:
1. See Section 40 23 43 PROCESS VALVES for valve type description.
2. MOD - Modulating
   - OC - Open/Close operation
   - OCS - Open/Close/Stop operation
3. See Section 40 92 13 MOTORIZED OPERATORS for motorized operator requirements.
4. FO - Fail Open
   - FC - Fail Close
   - FLP - Fail Last Position
   - FLP/FC - Fail Last Position and Fail Close (selector switch)
5. Division 40 includes certain Powered Operated Valves, in addition to the valves specified above, that shall be provided as specified and shown on the Drawings.
### 40 23 43.2: PROCESS VALVES AND OPERATORS

**SELF-CONTAINED VALVE SCHEDULE**

<table>
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<tr>
<th>TAG NO.</th>
<th>P&amp;ID DRAWING</th>
<th>FLOW STREAM ID</th>
<th>VALVE TYPE</th>
<th>SIZE (IN)</th>
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**NOTES:**

1. See Section 40 23 43, PROCESS VALVES AND OPERATORS, for valve type description.
2. Drawings include certain Self-Contained Valves, in addition to the valves specified above, that shall be provided as required on the Drawings and as specified.
<table>
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<tr>
<th>TAG NO.</th>
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**NOTES:**
1. See Section 40 23 43, PROCESS VALVES AND OPERATORS, for valve type description
2. Drawings and Division 40 include certain Solenoid Operated Valves, in addition to the valves specified above, that shall be provided as required on the Drawings and as specified.
SECTION 40 23 46 - STAINLESS STEEL SLIDE GATES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes: Stainless steel slide gates.

B. Related Requirements:
   1. Section 40 92 13 – Motorized Operators
   2. Section 40 92 16 – Manual Valve and Gate Operators

1.2 DEFINITIONS

A. FRP: Fiberglass-reinforced plastic.

B. Operating Head: Distance from centerline of gate to maximum water level of channel.

C. UHMW: Ultra-high molecular weight.

1.3 REFERENCE STANDARDS

A. American Water Works Association:
   1. AWWA C541 - Hydraulic and Pneumatic Cylinder and Vane-Type Actuators for Valves and Slide Gates.
   2. AWWA C542 - Electric Motor Actuators for Valves and Slide Gates.
   3. AWWA C561 - Fabricated Stainless-Steel Slide Gates.

B. NSF International:
   1. NSF Standard 61 - Drinking Water System Components - Health Effects.
   2. NSF Standard 372 - Drinking Water System Components - Lead Content.

1.4 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.

B. Product Data: Submit manufacturer information for system materials and component equipment.

C. Shop Drawings:
   1. Indicate system materials and component equipment.
   2. Submit installation and anchoring requirements, fasteners, and other details.
   3. Indicate gate identification number, location, service, type, size, design pressure, operator details, stem details, and loads.

D. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

E. Delegated Design Submittals: Submit signed and sealed Shop Drawings with design calculations and assumptions for seating and unseating pressure.

F. Manufacturer Instructions: Submit detailed instructions on installation requirements, including storage and handling procedures.

G. Source Quality-Control Submittals: Indicate results of factory tests and inspections.

H. Field Quality-Control Submittals: Indicate results of Contractor-furnished tests and inspections.
I. Manufacturer Reports:
   1. Certify that equipment has been installed according to manufacturer instructions.
   2. Indicate activities on Site, adverse findings, and recommendations.

J. Qualifications Statements:
   1. Submit qualifications for manufacturer, installer, and licensed professional.
   2. Submit manufacturer's approval of installer.

1.5 CLOSEOUT SUBMITTALS

A. Section 01 77 00 - Closeout Procedures: Requirements for submittals.

B. Project Record Documents: Record actual locations of installed slide gates and components.

1.6 QUALITY ASSURANCE


1.7 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this Section with minimum five years' experience.


1.8 DELIVERY, STORAGE, AND HANDLING

A. Section 01 60 00 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.

B. Inspection: Accept materials on Site in manufacturer's original packaging and inspect for damage.

C. Store materials according to manufacturer instructions.

D. Protection:
   1. Protect materials from moisture and dust by storing in clean, dry location remote from construction operations areas.
   2. Provide additional protection according to manufacturer instructions.

1.9 EXISTING CONDITIONS

A. Field Measurements:
   1. Verify field measurements prior to fabrication.
   2. Indicate field measurements on Shop Drawings.

1.10 WARRANTY

A. Section 01 77 00 - Closeout Procedures: Requirements for warranties.

B. Furnish three-year manufacturer's warranty for slide gates.

C. Furnish five-year manufacturer's warranty that clear plastic stem covers will not crack, discolor, or become opaque.
PART 2 - PRODUCTS

2.1 PERFORMANCE AND DESIGN CRITERIA

A. Seating and Unseating Pressure:
   1. As indicated in schedule following END OF SECTION.

B. Minimum Vertical Loading: 50 percent of force on the gate from operating head acting on horizontal centerline of gate, multiplied by effective gate area, plus weight of slide and stem.

C. Gate Reinforcement: As required for deflection not greater than 1/720 of span.

D. Operating Head:
   1. Safety Factor: Design gate to operate under specified operating head with safety factor per AWWA Standards.

2.2 STAINLESS STEEL SLIDE GATES

A. Manufacturers:
   1. Waco Products, Inc.
   2. Whipps, Inc.
   4. RW Gate

B. Description:
   1. Self-contained stainless steel slide gate with extended frame, yoke, lifting stem attached to yoke, lift and lift support, stem, stem guide, and stem block.
   2. Non-self-contained stainless steel slide gate with limited frame, lifting stem, lift and lift support, stem, stem guide, and stem block.
   3. Comply with AWWA C561.
   4. Size: As indicated in schedule following END OF SECTION.
   5. Operating Head: As indicated in schedule following END OF SECTION.
   6. Closure: As indicated in schedule following END OF SECTION.
   7. Opening: As indicated in schedule following END OF SECTION.

C. Gates:
   1. Material:
      a. Type 316 stainless steel.
   3. Size: As indicated in schedule following END OF SECTION.

D. Yokes:
   2. Mounting: Bolted to gate frame.

E. Seats:
   1. Impacted into dovetail slots and held in position without use of screws or other fasteners.
   2. Maximum Clearance between Seating Faces: 0.004 inch when gate is fully closed.

F. Wedges:
   1. Description: Machined brass blocks with angled faces and secured with a stud bolt to prevent slippage during operation.
   2. Furnish side, top, and bottom wedges.
G. Frames:
1. Configuration: One piece.
2. Material: Type 316 stainless steel.
4. Mounting: As indicated in schedule following END OF SECTION.
5. Furnish continuous embed or mounting flange.
7. Bottom Flush Closure: Resilient seal securely attached to frame along invert.

H. Lifting Devices:
1. Description: Stem, lifting nut, supports, bushings, stem cover, position indicator, and actuator as defined in gate schedule and 40 05 57 - Actuators for Process Valves and Gates.
3. Powered Lift Devices:
   a. As specified in Section 40 05 57 - Actuators for Process Valves and Gates.
   b. Comply with AWWA C541 and AWWA C542.

I. Handwheels:
1. Material: Cast aluminum.
2. Diameter: Minimum 24 inches.
4. Fully lubricated.
5. Mounting: Locate center 36 inches above operating floor.

J. Lifting Nut:
1. Material: Brass.
2. Furnish grease fitting.
3. Furnish polymer bearing pads above and below lifting nut.

K. Lifting Stem:
1. Material: Type 316 stainless steel.
2. Configuration:
   a. As specified in Gate Schedule.
   b. Removable.
3. Thread:
   a. Type: Acme, double lead.
   b. Cut threads are not acceptable.
4. Fully lubricated.
5. Maximum Number of Turns: 16 per foot of travel.
6. Stem Covers:
   b. Configuration: Capped and vented.
   c. Length: As required to allow full travel of gate.

2.3 FINISHES

A. Stainless Steel Surfaces: Mill finish.

2.4 ACCESSORIES

A. Hardware: Type 316 stainless steel.
2.5 SOURCE QUALITY CONTROL

A. Section 01 60 00 – Product Requirements: Requirements for testing, inspection, and analysis.

B. Inspection and Testing:
   1. Provide shop inspection and testing of completed assemblies.
   2. Comply with AWWA C561.

C. Owner Witnessing:
   1. Allow witnessing of factory inspections and test at manufacturer's test facility as requested by the Owner.
   2. Notify Owner at least seven days before inspections and tests are scheduled.

D. Certificate of Compliance:
   1. If manufacturer is approved by authorities having jurisdiction, submit certificate of compliance indicating Work performed at manufacturer's facility conforms to Contract Documents.
   2. Specified shop tests are not required for Work performed by approved manufacturer.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Section 01 77 00 - Closeout Procedures: Requirements for installation examination.

B. Verify that facilities are ready to receive slide gates.

3.2 PREPARATION

A. Section 01 77 00 - Closeout Procedures: Requirements for installation preparation.

B. Clean surfaces according to manufacturer instructions.

3.3 INSTALLATION

A. According to manufacturer instructions.

B. Ensure that products are installed plumb, true, and free of warp or twist.

C. Locate operators to avoid interference with handrails and other Work.

D. Guides:
   1. Surface and Flange Mounting:
      a. Install guides with expansion anchors.
      b. Position guides at elevation as indicated on Drawings.
   2. Recess Mounting:
      a. Cut slot in concrete to receive guides.
      b. Position guides at elevation as indicated on Drawings.
      c. Grout guides in place according to manufacturer instructions.

E. Sealant:
   1. Apply 1/8-inch-thick layer of elastomeric sealant to back of frame.
   2. Tighten nuts snug until sealant begins to flow beyond frame.
   3. Remove excess sealant.
   4. Cure sealant for minimum seven days.
5. Tighten nuts to their final positions.

F. Lubricants: Provide oil and grease as required for initial operation.

3.4 FIELD QUALITY CONTROL

A. Section 01 75 60 – Testing, Training, and Facility Start-up: Requirements for inspecting and testing.

B. Section 01 77 00 - Closeout Procedures: Requirements for testing, adjusting, and balancing.

C. Inspection:
   1. Verify alignment of gate and components.
   2. Verify that gate operates smoothly and does not bind or scrape.

D. Testing:
   1. Comply with AWWA C561.
   2. Leakage: Not exceeding 0.1 gpm/ft. of seating perimeter under 20 feet of seating head and not exceeding 0.21 gpm/ft. under 20 feet of unseating head.

E. Manufacturer Services: Furnish services of manufacturer's representative experienced in installation of products furnished under this Section for not less than 2 days on Site for installation, inspection, field testing, and instructing Owner's personnel in maintenance of equipment.

F. Equipment Acceptance:
   1. Adjust, repair, modify, or replace components failing to perform as specified and re-inspect.
   2. Make final adjustments to equipment under direction of manufacturer's representative.

G. Furnish installation certificate from equipment manufacturer's representative attesting that equipment has been properly installed and is ready for startup and testing.

3.5 ADJUSTING

A. Section 01 77 00 - Closeout Procedures: Requirements for starting and adjusting.

B. Adjust slide gates to provide smooth operation.

3.6 DEMONSTRATION

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for demonstration and training.

B. Demonstrate equipment operation, routine maintenance, and emergency repair procedures to Owner's personnel.

3.7 SUPPLEMENTS

A. The supplements listed below, following "END OF SECTION," are a part of this Specification.
   1. Fabricated Stainless Steel Slide Gate Schedule – New Gates
   2. Fabricated Stainless Steel Slide Gate Schedule – Retrofitted Gates

END OF SECTION
### 40 23 46.1: FABRICATED STAINLESS STEEL SLIDE GATE SCHEDULE – NEW GATES

<table>
<thead>
<tr>
<th>Gate ID Tag</th>
<th>Location</th>
<th>Opening Shape</th>
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<th>Design Operating Head Seating/Unseating Condition (feet)</th>
<th>Type of Operator (Note 4)</th>
<th>Stem Type</th>
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### 40 23 46.1: FABRICATED STAINLESS STEEL SLIDE GATE SCHEDULE – NEW GATES

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**General Notes:**
1. Refer to Drawing for structure finished floor and top of structure.
2. Invert elevation is bottom of gate in lowest position.
3. For weir type gates, invert elevation is top of weir most closed position.
4. * Denotes value to be confirmed by contractor for equipment selected.
5. Non self-contained, face mounted gates with pedestal mounted operators shall be provided with a wall bracket unless noted otherwise.

**Notes:**
1. SC = Self-Contained with Operator 3 feet above Walking Surface; NSC = Non Self-Contained.
2. STD = Standard; FB = Flushbottom; DO = Downward Opening; W = Weir
3. EMB = Embedded; FM = Facemounted; FLB = Flange Back; WT = Wall Thimble; CH = Channel Mounted
4. MO-MOD = Motor Operated - Modulating; refer to Section 40 23 43 for types of Electric Operators; MO-OC = Motor Operated – Open-Close; refer to Section 40 23 43 for types of Electric Operators; PMCO = Pedestal Mounted Crank Operator; PMHO = Pedestal Mounted Handwheel Operator; HO = Handwheel Operator; CO = Crank Operator; FBN = Floor Box with 2" Operating Nut

**Comments:**
1. Gates 30CG01 and 30CG02 are to be provided with interconnected geared yolk to operate in tandem, with a single actuator.
### 40 23 46.2: FABRICATED STAINLESS STEEL SLIDE GATE SCHEDULE – RETROFITTED GATES

<table>
<thead>
<tr>
<th>Gate ID Tag</th>
<th>Location</th>
<th>Opening Shape</th>
<th>Type of Frame (Note 1)</th>
<th>Type of Closure (Note 2)</th>
<th>Type of Mounting (Note 3)</th>
<th>Nominal Gate Width/Height (inches)</th>
<th>Opening Invert Elev. (feet)</th>
<th>Weir Cutout Width/Height (inches)</th>
<th>Weir Max/Min Invert Elev. (feet)</th>
<th>Design Operating Head Seating/Unseating Condition (feet)</th>
<th>Type of Operator (Note 4)</th>
<th>Stem Type</th>
<th>Operator Deck Elev. (feet)</th>
<th>Frame Height Above Deck (feet)</th>
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<td>597.50</td>
<td>0</td>
</tr>
</tbody>
</table>

**General Notes:**
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3. For weir type gates, invert elevation is top of weir most closed position.
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**Comments:** The above gates are existing and shall be converted from manually operated to electrically actuated as noted and detailed on the drawings. These are not new gates to be installed.
SECTION 40 24 00 - PROCESS PIPING SPECIALTIES

PART 1 - GENERAL

1.1 REFERENCES

A. The following is a list of standards which may be referenced in this section:
   1. American National Standards Institute (ANSI):
      a. A153, Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel
         Hardware.
      b. A276, Standard Specification for Stainless and Heat-Resisting Steel Bars and
         Shapes.
      Fire Service Mains and Their Appurtenances.

1.2 SUBMITTALS

A. Shop Drawings: Manufacturer’s data on materials, construction, end connections, ratings,
   overall lengths, and live lengths (as applicable).

PART 2 - PRODUCTS

2.1 GENERAL

A. Provide required piping specialty items, whether shown or not shown on the Drawings, as
   required by applicable codes and standard industry practice.

B. Rubber ring joints, mechanical joints, flexible couplings, and proprietary restrained ductile iron
   pipe joints are considered flexible joints; welded pipe joints are not.

2.2 CONNECTORS

A. Teflon Bellows Connector:
   1. Type: Two convolutions unless otherwise shown, with metal reinforcing bands.
   2. Flanges: Ductile iron, drilled 150 psi ANSI B16.5 standard.
   3. Working Pressure Rating: 140 psi, minimum, at 120 ° F.
   4. Thrust Restraint: Limit bolts to restrain the force developed by the specified test pressure.
   5. Manufacturers and Products:
      a. Garlock; Style 214.
      b. Resistoflex; No. R6904.

B. Elastomer Bellows Connector:
   1. Type: Fabricated spool, with single filled arch.
   3. End Connections: Flanged, drilled 125-pound ANSI B16.1 standard, with full elastomer
      face and steel retaining rings.
   5. Thrust Restraint: Control rods to limit travel of elongation and compression.
   6. Manufacturers and Products:
      b. Garlock; Style 204.
C. Sleeve Type Coupling Manufacturers:
   1. Dresser.
   2. Rockwell.

D. Closure Collar Concrete: As specified in Section 03 30 00, CAST-IN-PLACE CONCRETE.

2.3 EXPANSION JOINTS

A. Elastomer Bellows:
   1. Type: Reinforced, molded wide-arch.
   2. End Connections: Flanged, drilled 125-pound ANSI B16.1 standard with split galvanized steel retaining rings.
   3. Washers: Over the retaining rings to help provide a leak proof joint under test pressure.
   4. Thrust Protection: Control rods to protect the bellows from overextension.
   5. Bellows Arch Lining: Buna-N, nitrile, or butyl.
   6. Rated Temperature: 250° F.
   7. Rated Deflection and Pressure:
      b. Burst Pressure: Four times the working pressure.
      c. Compression deflection and minimum working pressure as follows:

<table>
<thead>
<tr>
<th>Size</th>
<th>Deflection</th>
<th>Pressure</th>
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<tr>
<td>(inch)</td>
<td>(inch)</td>
<td>(psig)</td>
</tr>
<tr>
<td>2-1/2 to 12</td>
<td>1.06</td>
<td>150</td>
</tr>
<tr>
<td>14</td>
<td>1.65</td>
<td>130</td>
</tr>
<tr>
<td>16 to 20</td>
<td>1.65</td>
<td>110</td>
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</table>

8. Manufacturers and Products:
   a. General Rubber Corp.; Style 1015 Maxijoint.
   b. Mercer; Flexmore Style 450.

B. Teflon Bellows:
   1. Type: Three convolutions, with metal reinforcing bands.
   2. Flanges: Ductile iron, drilled 150 psi ANSI B 16.5 standard.
   3. Working Pressure Rating: 100 psig, minimum, at 120° F.
   4. Thrust Restraint: Limit bolts to restrain the force developed by the specified test pressure.
   5. Manufacturers and Products:
      a. Garlock; Style 215.
      b. Resistoflex; No. R6905.

C. Copper Pipe Expansion Compensator:
   1. Material: All bronze.
   3. Accessories: Anti-torque device to protect the bellows.
   4. Manufacturers and Products:
      a. Flexonics; Model HB.
      b. Hyspan; Model 8509 or 8510.

D. Galvanized and Black Steel Pipe Expansion Compensator:
   3. Accessories: Anti-torque device to protect the bellows.
   4. Manufacturers and Products:
      a. Flexonics; Model H.
b. Hyspan; Model 8503.

E. Flexible Metal Hose:
1. Type: Close pitch, annular corrugated with single braided jacket.
3. End Connections:
   a. 3" and Larger: Shop fabricated flanged ends to match mating flanges.
   b. 2-1/2" and Smaller: Screwed ends with one union end.
4. Minimum Burst Pressure: 600 psig at 70° F for 12" and smaller.
5. Length: Provide hose live-length equal to the lengths shown on the Drawings.
6. Manufacturers and Products:
   a. Flexonics; Series 401M.
   b. Anaconda; BWC21-1.

2.4 FLEXIBLE PIPE CONNECTIONS TO EQUIPMENT

A. Manufacturers and Products:
1. Flexonics; Model TCS, with tie bolts.
2. Keflex; Type 152-TR, with tie bolts.

2.5 SERVICE SADDLES

A. Double-Strap Iron:
1. Pressure Rating: Capable of withstanding 150 psi internal pressure without leakage or over stressing.
2. Run Diameter: Compatible with the outside diameter of the pipe on which the saddle is installed.
4. Materials:
   a. Body: Malleable or ductile iron.
   b. Straps: Galvanized steel.
   c. Hex Nuts and Washers: Steel.
   d. Seal: Rubber.
5. Manufacturers and Products:
   a. Smith-Blair; Series 313 or 366.
   b. Dresser; Style 91.

B. Nylon-Coated Iron:
1. Pressure Rating: Capable of withstanding 150 psi internal pressure without leakage or over stressing.
2. Run Diameter: Compatible with the outside diameter of the pipe on which the saddle is installed.
3. Materials:
   b. Seal: Buna-N.
   c. Clamps and Nuts: Stainless steel.
4. Manufacturer and Product:
   a. Smith-Blair; Style 315 or 317.

2.6 INSULATING FLANGES, COUPLINGS, AND UNIONS

A. Materials:
1. In accordance with the applicable piping material specified in the Pipe Data Sheets.
2. Galvanically compatible with piping.
B. Union Type:
   1. 2" and Smaller: Screwed or solder-joint.
   2. 2-1/2" and Larger: Flanged, complete with bolt insulators, dielectric gasket, bolts, and nuts.

C. Working Pressure Rating: Suitable for specified system working pressure.

D. Manufacturers and Products:
   1. Dielectric Flanges and Unions:
      a. Epco Sales, Inc.
      b. Capitol Insulation Unions.
   2. Insulating Couplings:
      b. R. H. Baker; Series 216.

2.7 WALL PIPES

A. Ductile Iron Wall Pipe:
   1. For penetrations through concrete walls, floors, slabs, or roofs that are to be watertight.
   2. Diameter and Ends: Same as connecting ductile iron pipe.
   3. Thickness: Equal to or greater than remainder of pipe in line.
   4. Fittings: In accordance with applicable Pipe Data Sheet.
   5. Thrust Collars:
      a. Provide for all wall pipes.
      b. Rated for thrust load developed at 250 psi.
      c. Safety Factor: 2, minimum.
      d. Material and Construction:
         Ductile iron or cast iron, cast integral with wall pipe wherever possible. Fabricate welded attachment of ductile iron thrust collar to pipe where casting impossible. Perform in pipe manufacturer's shop by qualified welders. Electric arc welds of ductile iron with NI-55 or FC-55 nickel-iron-carbon weld rod. Continuously weld on each side all around.
   7. Coating After Fabrication: Prepare and coat wall pipe in accordance with and as specified in Section 09 90 00, PAINTING AND PROTECTIVE COATINGS, System No. 2

B. Steel or Stainless Steel Wall Pipe:
   1. Same material and thickness as connecting pipe, except 1/4-inch minimum thickness.
   2. Lining: Same as connecting pipe.
   3. Thrust Collar: Unless otherwise shown, 3 inches greater than outside diameter of wall pipe. Continuously fillet weld on each side all around.
   4. Coating After Fabrication: Prepare and coat wall pipe in accordance with and as specified in Section 09 90 00, PAINTING AND PROTECTIVE COATINGS, System No. 2
   5. Restraint: Provide lugs for use with thrust ties as specified.

2.8 PIPE SLEEVES

A. Steel Pipe Sleeve:
   1. Material: 3/16" minimum thickness steel pipe.
   2. Seep Ring:
      a. 3/16" minimum thickness center steel flange for water stoppage on sleeves in exterior or water-bearing walls.
      b. Outside Diameter: 3" greater than pipe sleeve outside diameter.
      c. Continuously fillet weld on each side all around.
   3. Factory Finish:
      a. Galvanizing:
Hot-dip applied, meeting requirements of ASTM A153. Electroplated zinc or cadmium plating is unacceptable.

b. Shop Lining and Coating: Factory prepare, prime, and finish coat in accordance with Section 09 90 00, PROTECTIVE PAINTING AND COATINGS, System No.2.

B. Insulated and Encased Pipe Sleeve:
1. Manufacturer: Pipe Shields, Inc.; Models WFB, WFB-CS and -CW Series, as applicable.

C. Modular Mechanical Seal:
1. Type: Interconnected synthetic rubber links shaped and sized to continuously fill annular space between pipe and wall sleeve opening.
2. Fabrication: Assemble interconnected rubber links with ASTM A276, Type 316 stainless steel bolts, nuts, and pressure plates.
3. Size: According to Manufacturer’s instructions for the size of pipes shown to provide a watertight seal between pipe and wall sleeve opening, and to withstand a hydrostatic head of 40 feet of water.
4. Manufacturer: Thunderline Link-Seal.

2.9 MISCELLANEOUS SPECIALTIES

A. Strainers for Process Water Service, 2” and Smaller:
1. Type: Bronze Body, Y-Pattern, 200 psi non-shock rated, with screwed gasketed bronze cap.
2. Screen: Heavy gauge Type 304 stainless steel or Monel, 20-mesh
3. Manufacturers:
   a. Armstrong International, Inc.; Model F
   b. Mueller Steam Specialty; Model 351M.

B. Strainers for CPVC, Plastic Piping Systems, 4” and Smaller:
1. Type: Y-pattern CPVC body, 150 psi non-shock rated, with screwed CPVC cap; and PTFE Teflon seals as recommended by manufacturer for service.
2. End Connections: Screwed or solvent weld, 2” and smaller. Class 150 ANSI flanged, 1-1/2” and larger.
3. Screen: Heavy-gauge CPVC, 1/32” mesh, minimum 2 to 1 screen area to pipe size ratio.
4. Manufacturers and Products: Hayward; Series 85/80, or equal.

C. Spray Nozzles:
1. Scum Spray Nozzle Type 1:
   a. Spray Pattern: Even
   b. Spray Angle: 140° at 60 psi
   c. Material: 316 Stainless Steel
   d. Deflection Angle: 75°
   e. Capacity: 8 gpm at 40 psi
   f. Size: 1/2” NPT
   g. Provide nozzle with adjustable ball fitting
   h. Manufacturer and Product: Spraying System Co., Nozzle Type K; or equal.
2. Scum Spray Nozzle Type 2:
   a. Spray Pattern: Solid narrow angle cone-shaped spray pattern with round impact area
   b. Spray Angle: 15° at 40 psi
   c. Material: 316 stainless steel
   d. Capacity: 3 gpm at 40 psi
   e. Size: 1/4” NPT
   f. Provide nozzle with adjustable ball fitting
   g. Manufacturer and Product: Spraying System Co., Nozzle Type G-15; or equal.
3. Scum Spray Nozzle Type 3:
a. Spray Pattern: Deflected flat spray pattern at low pressure
b. Counterweight lever which when lifted, allows the solid stream flow to purge nozzle.
c. Material: Bronze with neoprene rubber deflector
d. Size: 1/4" NPT
e. Manufacturer and Product: Spraying System Co., 22561 Foam Control Spray Nozzles; or equal.

D. Quick Couplings:
1. Provide female NPT by male quick-connect hose adaptors. All adapters and couplers shall satisfy dimensional requirements of MIL-C-27487E and shall be cast iron and sized shown on the Drawings.
2. Manufacturers and Products: Swagelock; Series QH.

E. Quick Disconnect Cam Operating Couplings for Chemical Service:
1. Type: Twin cam arm actuated, male and female, locking, for chemical loading and transfer.
2. Material: Glass-filled polypropylene and PVDF with Teflon gaskets and as recommended for the service by Manufacturer.
3. End Connections: NPT threaded or flanged to match piping connections.
4. Hose shanks for chemical installations.
5. Plugs and Caps: Female dust cap for each male end, male dust plug for each female end.
6. Pressure Rating: 125 psi, minimum at 70° F.
7. Manufacturers:
   a. OPW; Kamlock
   b. Ryan Herco; 1300 Series
   c. Goodall; Basic Eight

F. Chemical Injection Quills:
1. Retractable injection quill, service rated for 250 psi, including stainless steel check valve, ball valve, solution tube adaptor, packing nut, restraint system, and limit chains, and 300 Series O-ring gaskets.
2. Manufacturer and Products: SAF-T-FLO; or equal.

PART 3 - EXECUTION

3.1 SHIPPING, STORAGE, HANDLING, AND PROTECTION
A. As specified in Section 01 60 00, PRODUCT REQUIREMENT.
B. Install process piping specialties in accordance with manufacturer's directions, as shown on the Drawings, and as specified herein.

3.2 PIPING FLEXIBILITY PROVISIONS
A. General:
   1. Install thrust protection.
   2. Install flexible couplings to facilitate piping installation, in accordance with approved shop drawings.
B. Flexible Joints at Concrete Backfill or Encasement: Install within 18” or one-half pipe diameter, whichever is less, from the termination of any concrete backfill or concrete encasement.
C. Flexible Joints at Concrete Structures:
1. Install 18" or less from the face of structures; joint may be flush with face.
2. Install a second flexible joint, whether or not shown.
   a. Pipe Diameter 18" and smaller: Within 18" of the first joint.
   b. Pipe Diameter Larger than 18": Within one pipe diameter of the first joint.

3.3 PIPING TRANSITION

A. Applications:
   1. Provide complete closure assembly where pipes meet other pipes or structures.
   2. Pressure Pipeline Closures: Plain end pieces with double flexible couplings, unless otherwise shown.
   3. Restrained Joint Pipe Closures: Install with thrust tie-rod assemblies as shown or in accordance with NFPA 24.
   4. Gravity Pipe Closures: As specified for pressure pipelines, or concrete closures.
   5. Concrete Closures: Use to make connections between dissimilar pipes where standard rubber gasketed joints or flexible couplings are impractical, as approved.
   6. Elastomer sleeves bonded to pipe ends are not acceptable.

B. Installation:
   1. Flexible Transition Couplings: Install in accordance with coupling Manufacturer's instructions to connect dissimilar pipe and pipes with a small difference in outside diameter.
   2. Concrete Closures:
      a. Locate away from structures so that there are at least two flexible joints between the closure and pipe entering the structure.
      b. Clean pipe surface before closure collars are placed.
      c. Wet non-metallic pipe thoroughly prior to pouring collars.
      d. Prevent concrete from entering pipe.
      e. Extend collar a minimum of 12" on each side of joint with minimum thickness of 6" around outside diameter of pipe.
      f. Make entire collar in one placement.
      g. After concrete has reached initial set, cure by covering with well moistened earth.

3.4 PIPING EXPANSION

A. Piping Installation: Allow for thermal expansion due to differences between installation and operating temperatures.

B. Expansion Joints:
   3. Screwed and Soldered Piping Systems: Copper or Galvanized and Black Steel Pipe Expansion Compensator, as applicable.
   4. Pipe Run Offset: Flexible Metal Hose.

C. Anchors and Anchor Walls: Install as specified in Section 22 05 29, PROCESS SUPPORTS AND ANCHORS, to withstand expansion thrust loads and to direct and control thermal expansion.

3.5 SERVICE SADDLES AND THRUST TIES

A. Service Saddles:
   1. Ferrous Metal Piping (except stainless steel): Double-strap iron.
B. Thrust Ties:
1. Install where shown and where required to restrain the force developed by the specified test pressure.
2. Steel Pipe: Attach with fabricated lugs.
3. Ductile Iron Pipe: Attach with socket clamps against a grooved joint coupling or flange.
4. Flanged Coupling Adapters: For exposed installations, install Manufacturer’s anchor studs through the coupling sleeve.

C. Installation: Install in accordance with Manufacturer’s written instructions.
1. Before coupling, clean pipe holdback area of oil, scale, rust, and dirt.
2. Remove pipe coating if necessary to present smooth surface.

3.6 FLEXIBLE PIPE CONNECTIONS TO EQUIPMENT
A. Tie Bolts: Tighten snug prior to applying any pressure to the system.

3.7 INSULATING FLANGES, COUPLINGS, AND UNIONS
A. Applications:
1. Copper to ferrous metal piping connections.
2. Cathodically protected piping penetration to buildings and watertight structures.
3. Submerged to un-submerged metallic piping connections.

B. Installation of Insulating Kits: Drill oversize to accommodate insulating sleeves through the bolt holes, assuming standard bolt sizes.

C. Pipe Installation:
1. Insulating joints connecting immersed piping to non-immersed piping shall be installed above maximum water surface elevation.
2. All submerged carbon steel, ductile iron, or galvanized piping in reinforced concrete basins shall be isolated from the concrete reinforcement steel.

3.8 WALL PIPES
A. Applications:
1. As specified in Section 40 23 39, PROCESS PIPING - GENERAL
2. Watertight and Below Ground Penetrations:
   a. Wall pipes with thrust collars.
   b. Provide taps for stud bolts in flanges to be set flush with wall face.
   c. Existing Walls: Rotary drilled holes.
3. Wall Pipe Installation:
   a. Isolate embedded metallic piping from concrete reinforcement.
   b. Support wall pipes securely by formwork to prevent contact with reinforcing steel and tie-wires.

3.9 PIPE SLEEVES
A. Application:
1. As specified in Section 40 23 39, PROCESS PIPING - GENERAL.
2. Above Grade in Non-submerged Areas: Hot-dip galvanized after fabrication.
3. Below Grade or in Submerged or Damp Environments: Shop-lined and coated.

B. Installation:
1. Support non-insulating type securely in form work to prevent contact with reinforcing steel and tie-wires.
2. Caulk joint with rubber sealant or seal with wall penetration seal.

3.10 MISCELLANEOUS SPECIALTIES

A. Install in accordance with manufacturer's instructions.

END OF SECTION
SECTION 40 41 13 – HEAT TRACING

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes: Basic requirements for heat tracing including:
   1. Heating Cables.
   2. Control Panels.
   3. Temperature Sensors.
   4. Temperature Controllers.
   5. Contactors.
   7. All other auxiliary equipment and controls required to complete a heat tracing system.

B. Related sections:
   1. The Contract Documents are complementary; what is called for by one is as binding as if called for by all.
   2. It is the Contractor’s responsibility for scheduling and coordinating the Work of subcontractors, suppliers, and other individuals or entities performing or furnishing any of Contractor’s Work.
   3. The following Sections are related to the Work described in this Section. This list of Related Sections is provided for convenience only and is not intended to excuse or otherwise diminish the duty of the Contractor to see that the completed Work complies accurately with the Contract Documents.
      a. Section 01 33 00 – Submittal Procedures.
      b. Section 40 42 00 – Mechanical Insulation.

1.2 REFERENCES

A. The following is a list of standards which may be referenced in this section:
   3. Factory Mutual Research Corp. (FM).
   4. Institute of Electrical and Electronic Engineers (IEEE):
      b. IEEE 622 – Design & Installation of Electric Heat Tracing SY.
   6. National Electrical Manufacturers’ Association (NEMA):
      a. 1CS1-110.
   8. Occupational Safety and Health Standards (OSHA).
   9. Underwriters’ Laboratories, Inc. (UL):

1.3 SUBMITTALS

A. Submittals shall be made in accordance with Section 01 33 00, SUBMITTAL PROCEDURES.

B. Product Data:
1. Catalog number, wattage output, voltage rating, and product data.
2. Installation instructions.
3. Warranty.

C. Shop Drawings: Include isometric drawings for each heat traced pipe showing installation details, and size and type of heat tracing cable.

1.4 QUALITY ASSURANCE

A. Regulatory Requirements and Reference Standards: The electric heat tracing system shall conform to this specification and shall be designed, manufactured and tested in accordance with the minimum applicable requirements of the latest edition of the following codes and standards. Additional specific requirements shall be further defined in the testing requirements for each section.

1.5 WARRANTY

A. Cables: All cables shall be warranted for a period of 10 years for manufacturing defects.

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

A. Design Requirements:
   1. General: Heat tracing applications up to a maintain temperature of 250 degrees Fahrenheit and intermittent exposure to 420 degrees Fahrenheit shall use self-regulating heating cables and pads.
   2. Self-regulating heating cable shall vary its heat output relative to the temperature of the surface of the pipe or the tank allowing cable to be crossed over itself without overheating and to be cut to length in the field.
   3. Design for a useful life of 20 years or more with "power on" continuously. The criteria for life shall be to retain at least 75 percent of its original power when tested according to UL 746B.

2.2 HEAT TRACING CABLE

A. Self-regulating and self-limiting, 5 watts per foot, 120 volts, 60 hertz, flexible twin 16 AWG copper bus wires, with tinned copper braid overshield.

B. Manufacturers: One of the following or equal:
   1. Raychem Chemelex Auto-Trace.
   2. Chromalox Type SLR Rapid Trace.
   3. Thermon, BSX.
   4. Nelson, CLT or LT.

2.3 CONTROLLER

A. Manufacturer: One of the following or equal:
   1. Raychem Monitrace1000.

B. Operating Characteristics:
   1. Controller shall provide continuous monitoring of heat tracing circuit analyzing temperature through a hard-wired RTD.
2. Controller shall energize system automatically if the temperature drops below a preset point. Controller shall be equipped with local alarm to alert maintenance personnel if heat trace circuit is interrupted.
3. Controller shall have the capability of performing a self-diagnostic check on the system and advising maintenance personnel of the exact nature of any circuit problems.

C. Controller shall be fully compatible with heat trace and provided by same manufacturer as heat trace.
   1. Controller shall be powered from 208 VAC. A configurable dry contact shall be provided for heat trace fault.
   2. Controller shall have double pole solid state switching, temperature control from -40°F to 125°F and a 30-amp rating from -40°F to 125°F, ambient temperature.
   3. Power Supply: Controller power supply shall be either 110-240 VAC with adjustable ground fault detection.
   4. Controller shall have battery backup system to retain programmed parameters in the event of a power failure.
   5. Enclosure: Unit shall be enclosed in a NEMA 4X panel.
   6. Network Capabilities: Controller shall have network capabilities enabling monitoring and programming from a central location.

2.4 CONNECTION KITS, END SEALS, SPLICE AND TEE KITS

A. Heat trace connection, end, splice and tee kits shall be designed to meet or exceed the life of the heat trace and shall be given equal consideration and evaluation.

2.5 ACCESSORIES

A. Power connection kits.
B. Termination kits.
C. Splice kits.
D. End seal kits.
E. Straps.
F. Thermostat.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install heat tracing cable on piping subject to freezing in the following areas and as indicated on the Drawings (note that not all areas may be listed below):
   1. Headworks Screenings Area
      a. Step screens flushing water
      b. Sluice supply water
      c. Washing compactors supply water
   2. Final Clarifier No. 5
      a. Surface spray wash system
      b. Scum beach spray system

B. Wrap heat tracing tape with aluminum tape prior to installing insulation.
C. Install pipe insulation as specified in Section 40 42 00, MECHANICAL INSULATION.

D. Install heat tape and controls in accordance with manufacturer’s published installation instructions.

E. Thermostat:
   1. Thermostat shall be powered by 120 VAC.
   2. One single 120-volt power source will be provided to the heat tracing control system panel as indicated on the Drawings.
   3. Thermostats will be powered from the control panel box by the Contractor.

3.2 FIELD QUALITY CONTROL

A. Manufacturer’s Field Service.
   1. Inspect installed systems for proper installation.
   2. Instruct Owner’s personnel on operations and maintenance of the systems.

END OF SECTION
SECTION 40 42 00 – PROCESS MECHANICAL INSULATION

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes: Insulation, jackets, and accessories for piping and related systems. Refer to 23 07 13 Mechanical Insulation for HVAC related piping insulation requirements.

B. Related sections:
1. Section 01 33 00 – Submittal Procedures.
2. Section 09 90 00 – Painting and Protective Coatings.
3. Section 22 05 29 – Process Supports and Anchors.

1.2 REFERENCES

A. The following is a list of standards which may be referenced in this section:
   m. C929 – Standard Practice for Handling, Transporting, Shipping, Storage, Receiving, and Application of Thermal Insulation materials for Use in Contact with Austenitic Stainless Steel.
   o. D2310 – Classification of Machine-Made “Fiberglass” (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe.

1.3 DEFINITIONS

A. Buried: Piping that is installed below buildings, foundations or finish grade, either in soil or encased in concrete in soil.
B. Concealed: Piping above suspended ceilings and within walls, partitions, shafts, or service spaces and spaces not normally exposed to view but not buried.

C. Exterior: Piping that is installed outside a building or within a pipe trench or tunnel.

D. Flame Spread and Smoke Density: Burning characteristics determined in accordance with ASTM E84. No units apply to value.

E. Interior: Piping that is installed inside a building.

F. K Factor: Thermal conductivity determined in accordance with ASTM C177 or C518 and expressed in units of Btu-inch/hour-foot²–deg F.

G. Mineral Fiber: Fibers manufactured of glass, rock, or slag processed from a molten state, with or without a binder.

H. Water Vapor Permeance: Water vapor transmission determined in accordance with ASTM E96 and expressed in units of perm-inch.

1.4 SUBMITTALS

A. Submittals shall be made in accordance with Section 01 33 00, SUBMITTAL PROCEDURES.

B. Product Data:
   1. Insulation Properties: Include K factor, thickness, density, operating temperature limits, tensile strength, compressive strength, moisture absorption, flame spread, and smoke developed in accordance with ASTM E84 and corrosivity to stainless steel piping in accordance with ASTM C795.
   2. Jacket Properties: Include covering material, cover thickness, tensile strength, tear strength, permeability per ASTM E96, flame spread, and smoke developed in accordance with ASTM E84, closure type or devices, and accessories.
   3. Insulating Blankets: Include materials, performance characteristics, method of attaching to equipment, listing of locations where insulating blankets will be installed.

C. Manufacturer’s Application Instructions: Include assembly and application drawings and detailed instructions.

D. Laboratory Report: Provide certified laboratory report stating that insulation is not manufactured using chlorinated polymers and does not contain chlorides, bromides, sulfates, or fire-rated materials.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Store insulation materials and accessories under cover and protected from moisture.

B. Handle and store insulation for use on stainless steel in accordance with ASTM C929.

1.6 SEQUENCING AND SCHEDULING

A. Pressure test piping and complete application of coating system before applying insulation.

B. When piping is to be heat traced, install and functionally test heat tracing before installation of insulation.
C. Before beginning installation of piping insulation, verify that the Engineer has accepted piping tests, pipe coating applications, and heat tracing tests.

1.7 WARRANTY

A. Furnish one – year minimum warranty.

B. Furnish five – year manufacturer warranty.

PART 2 - PRODUCTS

2.1 PIPE INSULATION, GENERAL REQUIREMENTS

A. Insulation Thicknesses: Provide insulation thickness in inches in accordance with the following table. Insulation thickness shown is nominal manufacturing tolerance of 15 percent variation is permissible.

<table>
<thead>
<tr>
<th>SERVICE TEMPERATURE RANGE AS DESIGNATED IN INSULATION SCHEDULE AT END OF THIS SECTION</th>
<th>Nominal Pipe Diameters</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1 inch &amp; less</td>
</tr>
<tr>
<td>Above 200 deg F</td>
<td>2.0</td>
</tr>
<tr>
<td>100 to 200 deg F</td>
<td>1.5</td>
</tr>
<tr>
<td>40 to 100 deg F</td>
<td>0.5</td>
</tr>
<tr>
<td>Below 40 deg F</td>
<td>1.0</td>
</tr>
<tr>
<td>Heat Traced Pipes</td>
<td>1.0</td>
</tr>
<tr>
<td>Aeration Air Pipes</td>
<td>0.5</td>
</tr>
</tbody>
</table>

2.2 PIPE INSULATION

A. Insulation Types: Provide in accordance with the insulation types listed and scheduled.

B. Insulation, Type 1:
1. Insulation Material: Closed cell elastomeric insulation
2. Minimum Temperature Range: Minus 40 deg F to plus 220 deg F.
3. K Factor at 75 deg F: Not more than 0.27 BTU-in/hr-sq ft-deg F.
4. Fire Ratings:
   a. Flame Spread: 25 or less.
   b. Smoke Density: 50 or less for insulation thicknesses up to 1.5 inches.
5. Joints: Seal with manufacturer’s recommended contact adhesive to form continuous water barrier.
6. Manufacturers: One of the following or equal:
   a. Armacell Engineered Systems, AP/Armaflex

C. Insulation, Type 2:
1. Insulation Material: Preformed mineral fiberglass insulation made from glass fibers bonded with a thermosetting resin.
   a. Conform to ASTM C547, Class 1.
   b. Provide with factory installed vapor barrier.
1) Material: White kraft paper bound to aluminum foil meeting ASTM C1136, Type I.
2) Longitudinal Lap Seals: Pressure-sensitive, self-sealing longitudinal lap strip with factory applied adhesive.
3) Circumferential Butt Seals: 4-inch wide tape or similar properties or 4-inch wide overlap with adhesive seal.
4) Vapor Barrier Permeability: 0.02 perms or lower.
5) Vapor Barrier Flame Spread Rating: 25 or less.

2. Minimum Temperature Range: Minus 0 deg F to plus 850 deg F.
3. K Factor at 75 deg F: Not more than 0.23 BTU-in/hr-sq ft-deg F.
4. Average Insulation Density: 3.3 pounds per cubic foot.
5. Maximum Moisture Absorption, Volume Percent: 0.2.
6. Manufacturers: One of the following or equal:
   a. Owens-Corning Fiberglass Corp.
   b. Johns Manville
   c. Knauf Insulation

D. Insulation, Type 3:
1. Insulation Material: Rigid polyisocyanurate foam in accordance with ASTM C591, Type IV.
2. Temperature Range: Minus 297 deg F to plus 300 deg F.
3. K Factor at 75 deg F: Not more than 0.19 BTU-in/hr-sq ft-deg F.
4. Minimum Average Density: 4.0 pounds per cubic foot.
5. Maximum Moisture Absorption, Volume Percent: 0.7.
6. Minimum Compressive Strength: 25 pounds per square inch.
7. Moisture Permeability: 4.00 perm-inch.
8. Manufacturers: One of the following or equal:
   a. ITW.
   b. Dyplast.
   c. or Equal.

E. Insulation, Type 4:
1. Insulation Material: Rigid cellular glass in accordance with ASTM C553, Type II.
2. Temperature Range: Minus 450 deg F to plus 900 deg F.
3. K Factor at 75 deg F: Not more than 0.32 BTU-in/hr-sq ft-deg F.
4. Minimum Average Density: 7.5 pounds per cubic foot.
5. Maximum Moisture Absorption, Volume Percent: 0.2.
6. Minimum Compressive Strength: 87 pounds per square inch.
7. Moisture Permeability: 0.00 perm-inch.
8. Manufacturers: One of the following or equal:
   a. Pittsburgh Corning Corporation, Foamglas.
   b. Cell-U-Foam Corporation, Ultra-CUF.

F. Insulation, Type 5:
1. Insulation Material: Asbestos free, rigid calcium silicate in accordance with ASTM C533; Type 1 for process temperatures up to 1,200 deg F.
2. K Factor at 500 deg F: 0.55 for Type 1.
3. Maximum Average (Dry) Density: 14.5 pounds per cubic foot.
4. Compressive Strength: 100 pounds per square inch, to produce a 5 percent compression.
5. Manufacturers: One of the following or equal: In accordance with ASTM C533 Type I:
   a. Industrial Insulation Group, LLC, Thermo-12 Gold.

2.3 INSULATION JACKETS

A. Jacket, Type 1:
1. Material, 28 ounces per square yard polyvinyl chloride on polyester fabric; total thickness 0.028 inches minimum.
2. Fire Rating: 25 maximum flame spread, smoke developed 50 or less.
3. Color: As selected by the Engineer from manufacturer’s standard colors.
4. Overlap: One-inch minimum at joints and fittings.
7. Manufacturers: One of the following or equal:
   a. Accessible Products Company

B. Jacket, Type 2:
1. Material: Ultraviolet resistant polyvinyl chloride jacketing, 20 mil minimum thickness.
2. Fire Rating: 25 maximum flame spread, smoke developed 50 or less.
4. Overlap: One-inch minimum at joints and fittings.
5. Joint Seal: PVC solvent welded or adhesive as recommended by the manufacturer.
7. Manufacturers: One of the following or equal:
   a. Johns Manville, Zeston 2000 PVC.
   b. Proto Corp., LoSMOKE PVC.
   c. Speedline Smoke Safe PVC Jacketing System.
   d. Knauf Covering System.

C. Jacket, Type 3:
1. Material: Aluminum, Allow 5005; 0.016-inch (26 gauge) minimum thickness.
2. Overlap: Overlap circumferential joints 4 inches minimum; overlap longitudinal joints 1-inch minimum; longitudinal joints oriented to minimize water entry.
3. Bands: 0.5 inch wide, 0.0508 inch (16 gauge) thick aluminum, same alloy as jacket or 0.0179-inch thick Type 304 stainless steel; install on 18-inch centers, uniformly spaced and at all fitting joints.
5. Fittings: Custom fit of same materials.
6. Manufacturers: One of the following or equal:
   a. Childers Products.

2.4 VAPOR BARRIERS

A. Vapor Barrier, Type 1:
1. Material: White kraft paper bound to aluminum foil and meeting requirements of ASTM C1136, Type 1.
2. Permeability: 0.02 perms or lower.
4. Edge Seal: Pressure sensitive tape lap seal.
5. Circumferential Joints: 4-inch wide tape or 4-inch overlap with adhesive seal.
6. Manufacturers: One of the following or equal:
   a. Owens-Corning Fiberglass Corp., all service jackets with double sure adhesive lap seal.
   b. Schuller, Micro-Lok AP-T plus.

B. Vapor Barrier, Type 2:
1. Material: Mastic.
2. Manufacturers: One of the following or equal:
   a. Foster Products, 36-10/46-10 Weatherite.
   b. Childers Products CP10/11 Vi-Acryl.
2.5 RELATED MATERIALS

A. Cover Adhesive: Premium adhesive as recommended by the insulation cover supplier for heavy-duty service in corrosive, wet environments. Standard duty adhesives are not permitted.

2.6 REMOVABLE INSULATING BLANKETS

A. In piping systems specified to be insulated, use removable insulating blankets for valves, meters, strainers, filters, catalytic converters, engine exhaust silencers, and other in-line piping appurtenances and equipment requiring periodic servicing.

B. Size Limits: Use removable insulating blankets for equipment and piping appurtenances 3-inch in nominal size and larger. Insulate equipment and piping appurtenances less than 3-inch with molded sections of insulation or by field cutting insulation to conform to the shape of the component and to fit tightly around the component.

C. Manufacturers: One of the following or equal:
   1. Pittsburgh Corning, Temp-Mat.
   2. Accessible Products.

D. Low temperature insulating blankets rated up to 800 deg F:
   1. Use: For service temperatures up to 800 deg F.
   2. Insulation: Fiberglass fiber, K factor 0.27 at 75 deg F.
   3. Cover: 17-ounce fabric with both sides covered with silicone impregnated glass cloth suitable for temperatures up to 800 deg F.
   4. Dover Fasteners: Use one of the following systems:
      a. Grommets in the blanket and stainless steel wire; or
      b. 1-inch wide straps with stainless steel rectangular ring buckles and Velcro on strap tail.

E. High temperature insulating blankets rated up to 1,400 deg F:
   1. Rated for sustained service temperatures up to 1,400 deg F.
   2. Insulation: Ceramic fiber, K factor 0.50 at 600 deg F, insulation material suitable for up to 2,300 deg F, thickness to match adjacent piping insulation specified thickness.
   3. Cover: 17-ounce silicone impregnated fiberglass cloth suitable for temperatures up to 1,400 deg F.
   4. Cover Fasteners: Use one of the following systems:
      a. Grommets in the blanket and stainless steel wire; or
      b. 1-inch wide straps with stainless steel rectangular ring buckles and Velcro on strap tail.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Verification of Conditions: Before installing insulation, verify satisfactory completion of pressure tests of piping systems and functional tests of heat tracing equipment.

B. Examine piping surfaces and verify that surfaces are dry and free of loose scale, rust, dirt, oil, or water before applying insulation. When specified, paint or coat pipe surfaces as specified in Section 09 90 00, PAINTING AND PROTECTIVE COATINGS.

C. Examine insulation materials and accessories before installation. Do not install insulation and jackets that have been damaged or insulation that has become wet due to exposure to water.
3.2 INSTALLATION

A. Install insulation and jacket materials in accordance with manufacturer’s written instructions.

B. Apply insulation in smooth, clean manner with tight and finished smooth joints. Fits insulation tightly against surfaces. Insulate each continuous run of pipe with full-length sections of insulation with a single piece cut to length to complete the run of pipe. Do not use cut pieces or scraps to complete the installation.

C. Butt longitudinal and circumferential insulation joints firmly together.

D. Maintain the integrity of vapor barrier jacketing. Do not use staples to hold vapor barrier overlaps in place.

E. Apply sealant or cement when previous applications of adhesives and cement have thoroughly dried.

F. Apply insulation to permit expansion or contraction of pipelines without damage to insulation or jacketing.

G. Fittings:
   1. Insulate fittings by covering with mitered sections of insulation or utilize factory-made prefabricated fitting shapes.
   2. Terminate preformed pipe jackets or covering at sufficient distance from flanges to permit removal of bolts.
   3. Overlap flange and flanged fitting insulation on adjacent pipe covering by at least 2 inches.

H. Valves:
   1. Insulate valves 3-inch in nominal size and larger with removable insulating blankets.
   2. Size blanket to extend up to packing gland only so that replacement of packing does not require removal of insulating blanket.

I. Provide continuous insulation through and over pipe supports and provide protection saddles at supports.

J. Extend insulation against insulation end protection shields or covers so that insulation voids do not exist and provide water tight end seals and covers where insulation terminates.

K. Insulate pipeline strainers to permit removal of strainer basket without disturbing insulation on strainer body.

L. Provide continuous pipe insulation and covering through sleeves or openings in walls and floors. When buried pipe enters a building through a below grade wall or slab penetration, begin insulation system on interior side of penetration.

M. Apply pre-molded pipe insulation with extended legs when used on pipe traced with either tubing or electric cable type.

N. For Type 1 or 2 jacket installation on piping with potential reach temperatures greater than 150 degrees F shall be thermally isolated from piping at all insulation closure locations (end caps, transitions, etc.).
### 3.3 INSULATION SCHEDULE

<table>
<thead>
<tr>
<th>Service Designation(1)</th>
<th>Location(2)</th>
<th>Insulation Type(3)</th>
<th>Jacket Type(3)</th>
<th>Service Temp. °F(4)</th>
<th>Vapor Barrier</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heat Traced Pipes (5)</td>
<td>Exterior</td>
<td>1 or 2</td>
<td>2</td>
<td>Use thickness established in Table in paragraph 2.1</td>
<td>Install on Type 2 insulation</td>
</tr>
</tbody>
</table>

**Notes:**
1. Refer to Process Piping Schedule in Section 40 23 39 for service designations.
2. Insulation jackets are not required for interior installations that are concealed. See definitions for description of concealed locations.
3. Contractor may select from options listed.
4. Unless noted otherwise, use service temperature range provided in this table to establish insulation thickness as required by Table in paragraph 2.1 A.
5. Insulate all piping systems that are specified to be heat traced.

**END OF SECTION**
SECTION 40 61 13 – PROCESS CONTROL SYSTEM GENERAL PROVISIONS

PART 1 - GENERAL

1.1 SUMMARY

A. The work to be included under this section shall consist of furnishing all materials, labor, equipment, tools, supplies, and incidentals necessary for the installation and testing of all process control systems.

B. Related Sections:
   1. Section 40 61 96 – Process Control Descriptions
   2. Section 40 63 43 – Programmable Logic Controllers
   3. Section 40 67 23 – Control Panels
   4. Section 40 68 63 – PLC and HMI Programming
   5. Section 40 70 00 – Instrumentation for Process Systems

1.2 REFERENCES

A. Definitions: Symbols, Definitions, and Abbreviations: All symbols, definitions, and engineering unit abbreviations utilized shall conform to IEEE 100-84, S50.1, and S51.1, where applicable.
   1. SCADA – Supervisory Control and Data Acquisition
   2. HMI – Human Machine Interface (Graphical Screens, Text Displays)
   3. OIT – Operator Interface Terminal
   4. PLC – Programmable Logic Controller
   5. I/O – Input/Output
   6. VFD – Variable Frequency Drive
   7. SSRVS – Solid State Reduced Voltage Starter (“Soft Starter”)
   8. RTU – Remote Telemetry Unit
   9. MTU – Master Telemetry Unit
   10. MCC – Motor Control Center
   11. Operating Program – Operating system, SCADA or other core software
   12. Integrated Operating Platform – System of installed, connected, and configured hardware, operating programs, and networking equipment.
   13. PLC and HMI Programming – Software configuration of operating programs to implement process control strategies
   14. Integrator – a company specializing in process control system implementation, networking, installation, and configuration.

1.3 SCOPE OF WORK

A. The Contractor shall engage the services of an Integrator, who together with the Contractor shall furnish all materials, equipment, labor, and services to achieve a fully functional process control system for this project.

B. The Contractor and Integrator shall be responsible for providing and installing all instrumentation, PLC control panels, networking equipment, and other control system hardware as specified for a complete process control system installation.

C. The scope of the instrumentation and control system for this project includes:
   1. Furnish, install, configure, and calibrate instrumentation as detailed on the drawings and in the specifications.
   2. Fabricate and install all control panels as indicated in the drawings. Terminate all field control wiring inside control panels.
3. Develop new PLC programming logic and HMI graphic screens to control and monitor the new RAS/WAS pump station. In general, the screens should follow high performance HMI standards, and provide process control and monitoring as described within Specification 40 61 96, PROCESS CONTROL DESCRIPTIONS.

4. Develop new PLC programming logic and HMI graphic screens to control and monitor the grit equipment. In general, the screens should follow high performance HMI standards, and provide process control and monitoring as described within Specification 40 61 96, PROCESS CONTROL DESCRIPTIONS.

5. Provide all hardware required to properly communicate between all control panels, whether or not explicitly identified in the drawings or specifications.

6. Install networking equipment and communication cables between control devices as indicating in the drawings and specifications and provide configuration of equipment to ensure proper communication between all devices associated with the integrated operating platform.

7. Modification to existing instrumentation and control systems as required to maintain process operations.

8. Provide overall coordination, installation, supervision, and installation of control panels, instrumentation, networking systems, and other miscellaneous control system components as specified.

9. Provide overall coordination, installation, and supervision of process control systems.

10. Execute the testing procedures outlined in this document.

D. Equipment manufacturer-supplied packages may be provided under other sections of this contract that may interface with the process control system via communications protocol and/or hard-wired I/O. Refer to the associated specification sections and the contract drawings for additional details. The Contractor shall be responsible for coordination, furnishing, installing, and configuring any communication devices or drivers necessary to ensure proper communication with each of the manufacturer-supplied systems.

E. Manufacturer-supplied control packages may include instrumentation or control panels that shall be installed and configured by the Contractor according to vendor instructions. Upon satisfactory installation, configuration, and calibration, the Contractor shall coordinate with each vendor to inspect finished work.

1.4 QUALITY ASSURANCE

A. The Contractor shall designate in writing the qualified Integrator, including a detailed listing of the firm, resumes and work history of each person working on the project, and project specific references. The qualifications of the Integrator shall be subject to approval of the Owner and the Engineer.

1.5 SUBMITTALS

A. Product Data:

1. Instrument Installation Details.
2. Certified Calibration Sheets.
3. Complete and detailed instruction manuals on each item furnished including but not limited to all devices and instruments. Information to be contained in the instruction manuals shall include but not be limited to drawings, dimensions, manufacturer's recommendations, ratings, performance charts, power requirements, schematics, maintenance requirements and procedures, calibration recommendations and procedures, repair instructions, complete and recommended spare parts lists and related information.
4. Proposed tagging and attachment materials and methods.

B. Shop Drawings shall be submitted for approval by the Engineer.
1. The Contractor shall submit to the Engineer, for approval, Shop Drawings of the equipment to be installed to meet the Specifications. The Drawings shall be supported by notes or written directions as required to fully define the installation. The submission shall be made as soon as feasible after award of the Contract and, in any event, shall be submitted and approval obtained before installation of the equipment.

2. The information required on the Shop Drawings shall include, but is not necessarily limited to, the following:
   a. Full and complete specifications covering the equipment proposed to be furnished.
   b. Detail Drawings showing plan, network connections and elevation dimensions of the equipment proposed to be furnished.
   c. Guarantees of performance of the equipment proposed to be furnished.
   d. Nearest location of factory maintenance and service facilities that will be available to service the equipment offered.
   e. To scale plans, sections and elevations detailing entire installation. Include mounting hardware, brackets, assemblies and other devices as required for a complete installation.

3. Control panels:
   a. Panel and sub-panel layout
   b. Point-to-Point Wiring Diagrams
   c. Interconnection drawings
   d. System hardware

C. Contract Closeout Submittals:
   1. Project Record Documents
   2. Operating and Maintenance Data
   3. Warranty

D. Instrumentation and control testing documents shall be submitted for approval by the Engineer:
   1. Credentials of technicians doing the inspection and testing
   2. Written certification as detailed under testing requirements in this specification section

1.6 DELIVERY, STORAGE, AND HANDLING

A. Storage and Protection: Delivery, storage, and handling shall be in accordance with Manufacturers’ recommendation and the requirements of other sections herein.

1.7 PROJECT AND SITE CONDITIONS

A. Environmental Requirements: Instrumentation and control elements may be installed outdoors exposed to sun, rain and excessive humidity and shall be capable of continuous operation without significant reduction of their operating life under the following ambient conditions:

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temperature</td>
<td>-25 °C to 80 °C</td>
</tr>
<tr>
<td>Pressure</td>
<td>650 mm Hg to 800 mm Hg</td>
</tr>
<tr>
<td>Relative Humidity</td>
<td>20% to 100% condensing</td>
</tr>
<tr>
<td>Vibration Frequency</td>
<td>10 - 2000 Hz</td>
</tr>
<tr>
<td>Vibration Position</td>
<td>1.5 mm peak-to-peak</td>
</tr>
<tr>
<td>Vibration Acceleration</td>
<td>10 G.</td>
</tr>
</tbody>
</table>
B. Where the ratings of individual components cannot meet the requirements, provide suitable means of physical protection. Suitable physical protection shall consist of an assembly which meets the requirements listed, while limiting the ambient conditions at the non-conforming component to 90% of the component's rating (Example: A component rated for vibration at only 5 G. acceleration would be required to be combined with vibration isolation to limit the acceleration of the component to 4.5 G. when subjected to ambient acceleration of 10 G. from 10 - 2000 Hz.).

C. Operating Environmental Conditions: All instruments and control devices provided shall be rated for continuous operation in their installed operating environment and shall be capable of continuous operation at the operating conditions without significant reduction of their operating life.

D. All controlling devices shall be NEMA or IEC rated.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 GENERAL

A. All meters, instruments, control units, and other components shall be the most recent field proven models marketed by their respective manufacturers at the time of the submittal of the shop drawings unless otherwise specified to match existing equipment.

B. Analog measurements and control signals shall be electrical and shall vary in direct linear proportion to the variable being measured. All analog signals whether inputs or outputs shall be 4-20mA DC unless otherwise noted. The analog input signals shall maintain loop integrity with the installation of properly sized resistors across the input terminals. Provide surge protection for all analog signal terminations.

C. All of the elements, instruments, accessories, and assemblies shall be installed in accordance with the manufacturer's installation instructions, and as detailed on the Drawings. Shielded instrumentation cables shall be used for all analog signals from the instruments to the programmable logic controller panels. Separate conduits shall be used for instrument power, instrument signals, and fiber optic cables.

D. All instruments installed outdoors subject to direct sunlight shall include a stainless steel sunshade.

E. All digital inputs and outputs shall be isolated from the field equipment through an interposing relay. The relays shall be mounted inside the cabinet housing the associated programmable logic controller as shown on Drawings.

F. The Contractor shall make the necessary power connections and signal connections from the field devices (i.e. instruments, control valves, etc.) to the programmable logic controllers.

G. The Contractor shall configure and verify proper operation of the Integrated Operating Platform, included but not limited to the following requirements:
   1. The PLCs, OITs, networking hardware, surge protection devices, uninterruptible power supplies, and other incidental equipment shall be configured and installed as shown on the Drawings and as specified herein.
   2. All networked devices shall be configured for proper communication via the topology and protocol shown on the Drawings or specified herein.
   3. Verify that all system devices power up, function and properly communicate prior to commencing any startup or testing procedures as described herein.
3.2 TESTING AND INSTALLATION REQUIREMENTS

A. Testing and Installation Requirements: The Contractor shall be required to coordinate the following services during construction related to the testing and installation of the process control system. The complete system testing shall include all PLCs, HMI software and hardware, network devices, interconnecting cables, and other peripheral devices required for a complete and functional system. The testing of the system shall occur in four stages: a Factory Readiness Test, a Site Readiness Test, a Functional System Test, and a Final Acceptance Test.

B. Factory Readiness Test
   1. A Factory Readiness Test shall be performed for each control panel fabricated and provided by the Contractor. The test will not typically include the Engineer or Owner; however, any of these parties shall be provided the opportunity to witness the test if desired. The Contractor shall provide notice to the Engineer a minimum of thirty (30) days in advance of the test.
   2. The purpose of the Factory Readiness Test is to verify that all hardware and wiring within the control panel has been properly constructed and ready for shipment to the project site.
   3. The Contractor shall assemble all hardware components within the specified enclosure, including the instruments, PLCs, network components and other required items. This assembly shall be complete and considered suitable for field installation.
   4. For the Factory Readiness Test, the Contractor shall demonstrate that the control panel is suitable for field installation by powering up each item and testing for proper network connections. In addition, the Contractor shall test each PLC input and output for proper operation from each field connection point within the control panel. The Contractor shall be responsible for all measurement and testing components required to complete the Factory Readiness Test.
   5. The Contractor shall be responsible for connecting test instruments to each PLC and verifying proper operation of each input and output. All wire and terminal numbers shall be checked for conformance with the submittal drawings during this Readiness Test.
   6. Each analog I/O point shall be checked for proper operation from each field connection point in the control enclosure. The Contractor shall simulate inputs and outputs in order to fully confirm the proper operation of each analog I/O.
   7. The Contractor may load a test program in the PLCs in order to facilitate the Factory Readiness Test.
   8. The Contractor shall submit documentation to the Engineer demonstrating satisfactory completion of the Factory Readiness Test prior to shipment of the control panels to the project site.

C. Site Readiness Test
   1. A Site Readiness Test shall be performed after the installation of all control system components including PLC control panels, communications, control wiring, device configurations, instrument calibrations, motor controllers, and variable frequency controllers in accordance with the Contract Documents. The test will typically not include the Engineer or Owner; however, any of these parties shall be provided the opportunity to witness the testing if desired.
   2. The purpose of this test is for the Contractor to verify the following:
      a. All instruments have been properly configured and calibrated
      b. All field control wiring has been properly installed and terminated
      c. All PLC control panel hardware is operating and communicating properly
      d. The installation is ready for the Integrator to load PLC and HMI programming and begin functional process control testing.
   3. Site Readiness Test shall include energization and testing for correct hardware integration of all system components, including PLC remote I/O assemblies, and reliable communications between components with correct protocols.
   4. Provide point-to-point wiring checks for continuity between field devices to final PLC I/O terminations.
5. To the greatest extent possible, the Contractor shall check I/O under process conditions to the end elements. For example, I/O for valve limit switches shall be checked by operating the valve to fully open and closed positions, rather than using jumpers or other means to simulate valve operation.

6. Provide verification and documentation of normally closed or normally open contacts for discrete I/O signals.

7. Discrete inputs shall be tested by operating the end device to force a signal change. Observe results on all indicators such as PLC register, panel light, etc.

8. Discrete output signals shall be tested by forcing a value in the PLC register. Observe that the connected equipment properly responds.

9. Analog inputs shall be verified at 0%, 25%, 50%, 75%, and 100% of span. Observe results on all indicators such as PLC register, digital panel meters, etc.

10. Analog outputs shall be tested by entering values in the PLC register to force the outputs at 0%, 25%, 50%, 75%, and 100% of span. Observe that the connected equipment properly responds.

11. Personnel performing the test shall have International Society of Automation (ISA) Certified Control Systems Technicians (CCST) or equivalent credentials as approved by the Engineer or Owner.

12. Provide written tests results documenting satisfactory completion of the Site Readiness Test.

D. Functional System Test

1. Upon the Engineer’s approval of the Site Readiness Test, the Integrator shall load the PLC and HMI programming to begin functional testing of control strategies.

2. The purpose of the functional system testing is to implement and test the automatic and manual process control strategies through PLC and HMI programming.

3. The Contractor shall be present during the duration of the functional testing to address any issues with hardware, wiring, or instrumentation modifications. The Contractor shall also be available to assist with equipment operations as necessary.

4. For this test, all equipment shall be installed, calibrated, and functioning as required in the contract documents.

5. Each analog and discrete I/O signal shall be checked through the PLC to the HMI screens to verify proper mapping of tags.

6. Functionality of the system shall be checked to ensure conformance with process control strategies.

7. PLC control loops shall be tuned to achieve stable process control.

8. If during the Functional System Test, the Engineer or Owner finds that process control is not achievable due to errors in the installation, the functional testing shall stop and the Contractor shall correct the installation and repeat the testing at no additional cost to the Owner.

E. Final Acceptance Test:

1. After the system has been started up and running in automatic control to the greatest extent possible, the Contractor shall conduct a Final Acceptance test of the completed installation. The test shall start after the Engineer has received marked record (as-built) drawings from the Contractor and when directed by the Owner/Engineer.

2. During this test, the Owner and Engineer shall have full use of the system. The duration of the test shall be 30 days.

3. Contractor personnel shall be readily available to address issues onsite during the acceptance test.

4. The system shall operate with 100% reliability during the test period. Failure shall be defined as the inability to control or indicate status of specified inputs or outputs or any specified function of the control systems as described herein caused by defective hardware or software furnished in this project. Failure of hardware or software shall require repair or remedy of the defect to the satisfaction of the Engineer/Owner within 2 days. If the problem cannot be repaired in this time, the test shall be aborted and restarted after the problem is resolved.
corrected and when directed by the Owner/Engineer. Restarting and satisfactory completion of the test shall be conducted at no additional cost to the Owner.

5. Throughout the duration of the test, no modifications shall be made to the system without prior approval from the Engineer or Owner.

3.3 TRAINING, STARTUP ASSISTANCE, & WARRANTY

A. Training: The Contractor shall provide training for the purpose of familiarizing Owner’s personnel with the process control system. All training shall be as scheduled by the Owner. The training shall be scheduled a minimum of thirty (30) days in advance of when it is to be given. Proposed training materials, including a detailed training agenda itemizing relative emphasis on various topics of each course, shall be submitted to the Owner and Engineer at least fourteen (14) days in advance of when the training is to begin. The course content shall include, but not be limited to, a description of system philosophy, all major hardware components utilized in the system and hardware maintenance practices.

B. Startup Assistance
1. The Contractor shall be responsible for furnishing a qualified technical representative who shall supervise the installation of equipment and/or install equipment, and who shall test, adjust, field calibrate, and fully commission all flow metering equipment, instrumentation equipment, control equipment, and accessories specified herein and required as integral components of the complete systems. The commissioning will be deemed to be complete only after all systems are found to be performing satisfactorily following the final balancing of plant operation. The guarantee period, during which all defective materials shall be replaced and all faulty workmanship will be corrected at no cost to the Owner, shall begin with the date on which the commissioning is judged to be complete.

C. Service:
1. Manufacturers shall provide as part of the equipment cost sufficient days of service by a factory-trained service engineer specifically trained on the type equipment herein specified to assist the Contractor during installation and start-up. The service time shall be sufficient to place the units in satisfactory service and instruct the Owner's personnel in proper operation and maintenance of the equipment.
2. A minimum of three (3) days service Engineer time shall be provided.

D. Maintenance Instruction:
1. Operating and maintenance instructions, along with a separate parts list, shall be furnished in three (3) copies to the Owner. Operating instructions shall also incorporate a functional description of the system, including the system schematics which reflect "as-built" modifications. Maintenance requirements particular to the system shall be clearly defined, along with calibration and test procedures.

E. Warranty:
1. All equipment and workmanship furnished under this contract shall be guaranteed to be free of defects in materials and workmanship for a period of one (1) year from and after the date of final acceptance of the work by the Owner, and any such defects which appear within the stipulated guaranty period shall be repaired, replaced or made good without charge. This guarantee shall include the capacity and integrated performance of the component's parts.

END OF SECTION
SECTION 40 61 96.00 - PROCESS CONTROL DESCRIPTIONS - GENERAL

PART 1 - GENERAL

1.1 SUMMARY

A. This section includes descriptions of process control strategies and intended functionality of new system equipment and processes. These descriptions shall serve as the starting point for process control and are expected to be continually refined throughout the execution of the project. The descriptions are not intended to identify every status or alarm indication required as part of the plant process control system. Refer to contract drawings and related specifications sections for additional process control information.

B. This section does not include process control strategies for equipment furnished as part of a vendor supplied control package. These systems will be programmed and implemented by the vendor. Refer to equipment specifications for process control requirements of vendor supplied systems.

C. PLC and HMI programming for process control strategy implementation, outside of vendor supplied systems, shall be provided by the integrator.

1.2 Related Requirements:

A. Section 40 61 13 – Process Control System General Requirements.

B. Section 40 68 63 – PLC and HMI Programming

1.3 DEFINITIONS

A. Integrated Operating Platform – System of installed, connected, and configured hardware, operating programs, and networking equipment.

B. PLC and HMI Programming – Software configuration of operating programs to implement process control strategies.

C. Integrator – a company performing the PLC and HMI programming to implement process control strategies.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 OVERALL PROCESS FLOW DESCRIPTION

The following provides a high-level description of the new and modified processes. Refer to the process control description attachments for further process control details about each facility.

A. FACILITY 10 – HEADWORKS

1. The headworks facility splits influent wastewater and directs flow to operating mechanical screens and vortex grit systems.

2. Screens will operate by differential level as controlled by vendor-furnished PLC-based system.

3. Screened and de-gritted flow is split at the headworks diversion structure between the existing aeration basin train and the oxidation ditch train using downward opening weir gates. Flow meters measure the flow to each train with readout provided at the weir.
gates. The flow split is adjusted by plant staff through adjustment of the weir gate position.

4. Screenings will travel by sluiceway to a screenings washer compactor. Plant water to this sluiceway will be supplied continually while screens are operating. The washer compactor will operate continually while screens are operating.

5. Grit pumps will pump grit slurry to grit classifiers per manufacturer’s preferred interval or not less than every 15 minutes while vortex grit units are receiving flow. Grit classifiers will operate continually while vortex grit units are operating.

B. FACILITY 20 – PROCESS TRAIN SPLITTER BOX NO.1
1. Process train splitter box no. 1 mixes RAS received from Final Clarifiers 3, 4 and 5 with flow received from the headworks diversion structure.
2. Mixers in the splitter box will operate continually.
3. Mixed flow will be split evenly via weir troughs to oxidation ditches 1, 2, and 3.

C. FACILITY 30 – OXIDATION DITCH NO.3
1. Oxidation ditch no. 3 aerators will be controlled with a VFD. The VFD will be operated and adjusted manually by the operator and run continuously.
2. The Oxidation ditch no. 3 mixer will be controlled with a constant speed starter. The starter will be operated manually by the operator and run continuously.
3. The water surface elevation in the ditch will be manually controlled via motor operated weir effluent gates.

D. FACILITY 40 – FINAL CLARIFIER NO.5
1. The primary purpose of the final clarifiers is to separate suspended solids from the mixed liquor. A passive suction mechanism will direct solids toward the central well to be either recycled or wasted via the RAS/WAS Pump Station.
2. Sludge blanket depth in the clarifiers will be checked periodically with a sludge judge device. RAS return rate will be monitored via flow meters on the RAS line from the RAS/WAS Pump Station. Operators will monitor the sludge blanket levels and RAS flow rate to ensure they are maintained in an acceptable range by modulating a telescoping valve at the Final Clarifiers.
3. The Final Clarifier drive motor will run continuously at a constant speed.
4. The Final Clarifiers will be provided with a spray water bar which will spray the clarifier water surface when a valve is opened manually.
5. The Final Clarifiers will be provided with automated spray water operated on a timer relay which will spray the scum beach periodically.
6. Two scum pumps in a duty/standby configuration will be controlled by a radar level transmitter/controller (40LIT501). The controller will be configured to close a relay contact wired to the pump starters whenever the level rises above 10 feet and will open the contact when the level drops below 6 feet. Pump control will alternate.
7. A low level lockout float switch shall be provided and connected directly to the pump motor control circuits for shutdown of all pumps to prevent the risk of damage to pumps (suspended float switch 40LSL501). A low level lockout shall be latched and require a manual reset at the PLC panel (40CP1) before pumps are allowed to start. A bypass switch will be provided for each wet well to bypass the low level lockout function.

E. FACILITY 50 – RAS/WAS PUMP STATION
1. Each wetwell shall include an ultrasonic level sensor for level measurement. Wet Well No. 1 shall utilize 50LE001 and Wet Well No. 2 shall utilize 50LE002.
2. One flow meter shall be provided on the RAS pump discharge header piping to measure RAS (50FE101).
3. One flow meter shall be provided on the WAS pump discharge header piping to measure WAS (50FE201).
4. High level alarms shall be provided in the wetwells (suspended float switches, 50LSH001 and 50LSH002 respectively). When the level in either wetwell reaches these float switches, an alarm will be displayed at the local HMI touchscreen.

5. Low level lockout float switches shall be provided and connected directly to the pump motor control circuits for shutdown of all pumps to prevent the risk of damage to pumps (suspended float switches, 50LSL001 and 50LSL002). A low level lockout shall be latched and require a manual reset at the PLC panel (40CP1) before pumps are allowed to start. A bypass switch will be provided for each wet well to bypass the low level lockout function.

6. Return Activated Sludge (RAS) Pump Control:
a. RAS is pumped from both wet wells to Process Train Splitter box No.1.
b. Local Control:
   1) When the HOA switch at the pump VFD is in the ‘Hand’ position, the VFD will receive a maintained run command. The pump speed may be adjusted locally via the speed potentiometer.
c. Remote Control:
   1) When the HOA switch at the pump VFD is in the ‘Auto’ position, the pump will be controlled remotely by the PLC in either ‘Remote Manual’ or ‘Remote Auto’ modes. Remote Manual/Auto shall be a software selection on the local OIT touchscreen.
      a) Remote Manual – Pump starts, stops, and speed setpoint adjustments can be made from the local OIT.
      b) Remote Auto – The PLC will automatically control pump speed in order to maintain a wet well level setpoint, adjustable from the OIT. The PLC will turn pumps on and off as needed in a lead/lag capacity. The lead/lag setting of each pump will be adjustable from the OIT. If a pump is not in ‘Remote Auto’, is faulted, or is otherwise unavailable, the PLC will remove that pump from the lead/lag lineup.
   d. A flow meter on the RAS discharge header will provide feedback of the total RAS flow to the splitterbox. This flow rate will be indirectly controlled by manually adjusting the telescoping valves at the final clarifiers. There is no direct PLC control of the RAS flow.

7. Waste Activated Sludge (WAS) Pump Control
a. WAS is pumped from both wet wells to an existing Solids Handling Facility.
b. Local Control:
   1) When the HOA switch at the pump VFD is in the ‘Hand’ position, the VFD will receive a maintained run command. The pump speed may be adjusted locally via the speed potentiometer.
c. Remote Control:
   1) When the HOA switch at the pump VFD is in the ‘Auto’ position, the pump will be controlled remotely by the PLC in either ‘Remote Manual’ or ‘Remote Auto’ modes. Remote Manual/Auto shall be a software selection on the local OIT touchscreen.
      a) Remote Manual – Pump starts, stops, and speed setpoint adjustments can be made from the local OIT.
      b) Remote Auto – The PLC will automatically control pump speed in order to maintain a flow rate setpoint as measured by the WAS discharge flow meter, adjustable from the OIT. Pumps will be started and stopped manually from the OIT. If both pumps are running in ‘Remote Auto’, the PLC will ramp both pumps together at the same speed to meet the flow rate setpoint.
SECTION 40 63 43 – PROGRAMMABLE LOGIC CONTROLLERS

PART 1 - GENERAL

1.1 SUMMARY

A. The work to be included under this section shall consist of furnishing all materials, labor, equipment, tools, supplies, and incidentals necessary for the installation and testing of all programmable logic controllers (PLCs).

B. Related Sections:
2. Section 40 67 23 – Control Panels
3. Section 40 70 00 – Instrumentation for Process Systems

1.2 REFERENCES

A. Definitions: Symbols, Definitions, and Abbreviations: All symbols, definitions, and engineering unit abbreviations utilized shall conform to IEEE 100-84, S50.1, and S51.1, where applicable.
1. SCADA – Supervisory Control and Data Acquisition
2. HMI – Human Machine Interface (Graphical Screens, Text Displays)
3. OIT – Operator Interface Terminal
4. PLC – Programmable Logic Controller
5. I/O – Input/Output
6. VFD – Variable Frequency Drive
7. SSRVS – Solid State Reduced Voltage Starter (“Soft Starter”)
8. RTU – Remote Telemetry Unit
9. MTU – Master Telemetry Unit
10. MCC – Motor Control Center
11. Operating Program – Operating system, SCADA or another core software
12. Integrated Operating Platform – System of installed, connected, and configured hardware, operating programs, and networking equipment.
13. PLC and HMI Programming – Software configuration of operating programs to implement process control strategies

1.3 QUALITY ASSURANCE

A. Manufacturer’s Support: The PLC system manufacturer shall maintain, as a part of a national network, engineering service facilities within 100 miles of the project, to provide start-up service, emergency service calls, repair work, service contracts, maintenance, and training. Emergency service shall be available within twenty-four hours of notification.

1.4 SUBMITTALS

A. Refer to specification 40 61 13 for submittal requirements.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Storage and Protection: Delivery, storage, and handling shall be in accordance with Manufacturers’ recommendation and the requirements of other sections herein.
PART 2 - PRODUCTS

2.1 PROGRAMMABLE LOGIC CONTROLLERS

A. Manufacturer:
   1. Rockwell Automation – Allen-Bradley ControlLogix

B. Components: The PLCs shall consist of the following basic components:
   1. Power supply module properly sized for the I/O load.
   2. Chassis with capacity for modules, including spares, as detailed in the plans.
   3. Processor module with sufficient memory for the application. Processors shall be the same model for all provided PLCs.
   4. Ethernet communication module.
   5. I/O modules as required for the application.
   6. Digital input cards shall be 16 channel.
   7. Digital output cards shall be 16 channel and of the relay type.
   8. Analog input cards shall be 8 channel and isolated.
   9. Analog output cards shall be 4 channel and isolated.

C. Features:
   1. Each PLC shall be installed with a minimum of 25% spare I/O points of each type. This spare requirement is in addition to any future tag requirements shown in the I/O list.
   2. Each PLC shall have a removable nonvolatile memory card installed with capacity greater than or equal to processor internal memory. The controller shall be configured to load a copy of the program from nonvolatile memory whenever there is no project in the controller and power is applied.
   3. The PLCs shall be capable of and shall be configured to provide stand-alone operation in the event of a communications link failure.
   4. The necessary interface cables, communications cables, power cables, bus extension cables, modular card slot fillers, and other ancillary parts shall be furnished and installed as integral parts of the control system.
   5. Nameplates shall be provided for each module, device, and other equipment with appropriate data such as the equipment number, rating, serial number, and manufacturer.
   6. All I/O cards shall be furnished with removable terminal blocks to simplify card wiring and replacement.

D. Spare Parts:
   1. The Contractor shall furnish the Owner the following spare replacement parts:
      a. One (1) processor module of each type
      b. Two (2) I/O modules of each type
      c. One (1) communication module of each type

2.2 PLC PROGRAMMING SOFTWARE

A. Manufacturer:
   1. Rockwell Automation

B. Software
   1. Studio 5000 Professional Edition
      a. Description: Integrated design environment for creating and modifying Allen-Bradley ControlLogix and CompactLogix PLC programs.
      b. Provide one license of the latest version at the time of submittal.
PART 3 - EXECUTION

3.1 GENERAL

A. The Contractor shall utilize personnel who are skilled and experienced in the installation, setup, and configuration of the PLCs being furnished under this contract.

B. Any PLC furnished as part of a vendor supplied equipment package shall be accessible for future program monitoring and revisions. If password protection of any kind is implemented, the vendor or Contractor shall supply all passwords or other security information to the Owner and the Engineer.

C. The Contractor shall furnish the Owner final as-built copies of documented PLC programs for vendor supplied equipment packages, on electronic media, suitable for future troubleshooting or modifications by others.

D. All components and assemblies shall be installed in accordance with the manufacturer’s installation instructions.

END OF SECTION
SECTION 40 67 23 – CONTROL PANELS

PART 1 - GENERAL

1.1 SUMMARY

A. This specification covers all control panels provided as part of the project, including those provided as part of an equipment manufacturer’s scope of supply.

B. Furnish and install functional control panels to manually or automatically operate control systems as specified in the detailed requirements of this section and related sections.

C. Related Sections:
   2. Section 40 63 43 – Programmable Logic Controllers

1.2 SUBMITTALS

A. Submittals shall contain information on related equipment to be furnished under this Specification but described in the related Sections listed in the Related Work paragraph above. Incomplete submittals not containing the required information on the related equipment will also be returned un-reviewed.

B. All submittals for control panels provided as part of an equipment manufacturer/vendor’s scope shall be submitted as a part of the Process Equipment manufacturer’s submittal.

C. All submittals for control panels provided by the Integrator shall be submitted as a part of the Integrator’s submittals.

D. The equipment manufacturer shall create all equipment shop drawings, including all wiring diagrams, in the manufacturer’s Engineering department. All equipment shop drawings shall bear the mechanical equipment manufacturer’s logo, drawing file numbers, and shall be maintained on file in the mechanical equipment manufacturer's archive file system.

E. Submit to the Owner/Engineer, shop drawings and product data, for the following:
   1. Custom unit elementary drawings. Drawings shall include all schematics for control logic as described in the Process Equipment Specifications, and any associated control schematics shown on the Engineer's Drawings for this project. Show interconnections between components and to remotely mounted devices. Include and identify all connecting equipment and remote devices on the schematics. The notation “Remote Device” will not be acceptable. Show wire and terminal numbers. Indicate special identifications for devices as required by the mechanical equipment manufacturer or as may be shown on the Drawings.
   2. Equipment outline drawings showing elevation, plan and interior views, front panel arrangement, dimensions, weight, shipping splits, conduit entrances and anchor bolt pattern. Indicate all options, special features, ratings and deviations from this Section.
   3. Power and control schematics including external connections. Show wire and terminal numbers and color-coding.
   4. Instruction and replacement parts books, including manufacturer's part numbers and selections of component ratings.
   5. As-built final drawings.
   6. Documentation that the panel assembly facility is a UL-508 certified facility.
   7. Furnish complete Bill of Materials indicating manufacturer's name and part numbers.
8. Manufacturer’s cut sheets for every component used in the panel assembly adequately marked to show the items being included. The manufacturer’s name shall be clearly visible on each cut sheet submitted.

9. Assembly ratings including:
   a. Short-circuit rating
   b. Voltage
   c. Continuous current

10. Major component ratings including:
    a. Voltage
    b. Continuous current
    c. Interrupting ratings

11. Cable terminal sizes.
12. Instruction and renewal parts books.

F. Factory Tests. Submittals shall be made for factory tests specified herein.

G. Field Test Reports. Submittals shall be made for field tests specified herein.

H. Operation and Maintenance Manuals.
   1. Operation and Maintenance Manuals shall include the following information:
      a. Manufacturer’s contact address and telephone number for parts and service.
      b. Instruction books and/or leaflets
      c. Recommended renewal parts list
      d. Record Documents for the information required by the Submittals paragraph above.

I. The manufacturer shall submit for approval, a training agenda for all training specified herein. Training agenda shall not be submitted until final approval of the Operation and Maintenance Manual.

1.3 REFERENCE CODES AND STANDARDS

A. All products and components shown on the Drawings and listed in this specification shall be designed and manufactured according to latest revision of the following standards (unless otherwise noted):
   1. NEMA Standard ICS 2 – 2000 Industrial Control and Systems
   2. NFPA 70 – National Electrical Code (NEC)
   3. NFPA 70E – Standard for Electrical Safety in the Workplace
   4. NFPA 79 – Electrical Standard for Industrial Machinery
   5. UL 508/508A – Industrial Control Enclosures

B. All equipment components and completed assemblies specified in this Section of the Specifications shall bear the appropriate label of Underwriters Laboratories.

1.4 QUALITY ASSURANCE

A. The manufacturer of the control panels shall have produced similar equipment for a minimum period of five (5) years. When requested by the Engineer, an acceptable list of installations with similar equipment shall be provided demonstrating compliance with this requirement.

B. The control panels shall be assembled in a UL-508 certified facility. A submittal of documentation certifying that the panel fabrication facility is a UL-508 certified facility, is required. A UL label shall be affixed to the inside of the external door by the panel fabrication assembly.
C. All components and material shall be new and of the latest field proven design and in current production. Obsolete components or components scheduled for immediate discontinuation shall not be used.

D. Control panels submitted shall fit within the space shown on the Drawings. Equipment which does not fit within the space is not acceptable.

E. For the equipment specified herein, the manufacturer shall be ISO 9001 2000 certified.

1.5 JOBSITE DELIVERY, STORAGE AND HANDLING

A. Prior to jobsite delivery, the Contractor shall have successfully completed all submittal requirements, and present to the Owner/Engineer upon delivery of the equipment, an approved copy of all such submittals. Delivery of incomplete constructed equipment, onsite factory work, or failed factory tests will not be permitted.

B. Equipment shall be handled and stored in accordance with manufacturer's instructions. Two (2) copies of these instructions shall be included with the equipment at time of shipment and shall be made available to the Contractor and Owner/Engineer.

C. Shipping groups shall be designed to be shipped by truck, rail, or ship. Indoor groups shall be bolted to skids. Breakers and accessories shall be packaged and shipped separately.

D. Where space heaters are provided in equipment, provide temporary electrical power and operate space heaters during storage, and after equipment is installed in permanent location, until equipment is placed in service.

1.6 WARRANTY

A. The Manufacturer shall warrant the equipment to be free from defects in material and workmanship for the same length of time as the associated mechanical equipment, but not less than 1 year from date of final acceptance of the equipment. Within such period of warranty, the Manufacturer shall promptly furnish all material and labor necessary to return the equipment to new operating condition. Any warranty work, requiring shipping or transporting of the equipment, shall be performed by the Manufacturer, at no expense to the Owner.

PART 2 - PRODUCTS

2.1 RATINGS

A. The service voltage shall be as specified and as shown on the Drawings. The overall short circuit withstand and interrupting rating of the equipment and devices shall be not less than 22,000 amperes RMS symmetrical for panels operating at 480/277V, and equal to or greater than the overall short circuit withstand and interrupting rating of the feeder device immediately upstream of the Control Panel. This includes all circuit breakers and combination motor starters. Systems of motor controllers employing series connected ratings for main and feeder devices shall not be used. Motor starter units shall be tested and UL 508A labeled for the specified short circuit duty in combination with the motor branch circuit protective device. The overall short circuit rating of the panel shall be not less than 10,000 amperes RMS symmetrical for panels operating at 120V ac.

B. There shall be selective device coordination between the Main Breaker, Feeder Breakers, and control circuit protective devices. When using a circuit breaker or fuses as a main protective device, the instantaneous trip levels of the main protective device shall be higher than the available fault current to the control panel. If fuses are utilized in the control panel design, the
protective devices for 3 phase loads shall contain single phase protection of such equipment. If a fault occurs in the circuit of one load of a design with a backup load, the feeder protective device shall not remove both loads from the control system.

C. The complete control panel assembly shall be UL certified and carry a UL listing for "Industrial Control Panels".

D. The control panel shall meet all applicable requirements of the National Electrical Code.

E. The control panel enclosure shall be NEMA rated as specified herein.

F. Motor controllers, including associated devices, shall be designed for continuous operation at rated current in a 40 degree C ambient temperature.

G. For additional ratings and construction notes, refer to the mechanical equipment specifications and the Drawings.

2.2 CONSTRUCTION

A. General

1. Submit actual layout and location of equipment and components; current ratings of devices, bus bars, components; protective relays, voltage ratings of devices, components and assemblies; and other required details. NEMA ratings of all devices shall meet or exceed the rating of each panel.

2. Control units shall be arranged as shown on the Drawings.

3. Nameplates
   a. Exterior
      1) Nameplates shall be engraved, laminated impact acrylic. Nameplates shall be 316 SS screw mounted to all enclosures except for NEMA 4 and 4X. Nameplates for NEMA 4 and 4X enclosures shall be attached with double faced adhesive strips. Prior to installing the adhesive nameplates, the metal surface shall be thoroughly cleaned with 70% alcohol until all residues have been removed. Epoxy adhesive or foam tape is not acceptable.
      2) There shall be a master nameplate that indicates supply voltage equipment ratings, short circuit current rating, manufacturer's name, shop order number and general information. Cubicle nameplates shall be mounted on the front face, on the rear panel and inside the assembly, visible when the rear panel is removed.
      3) Provide permanent warning signs as follows:
         a. "Danger - High Voltage- Keep Out" on all doors.
         b. "Warning- Hazard of Electric Shock - Disconnect Power Before Opening or Working On This Unit" on Main Power Disconnect or Disconnects.
   b. Internal
      1) Provide the panel with a UL 508A label.
      2) Control components mounted within the assembly, such as fuse blocks, relays, pushbuttons, switches, etc., shall be suitably marked for identification, corresponding to appropriate designations on manufacturer's wiring diagrams.

4. Control Devices and Indicators
   a. All operating control devices, indicators, and instruments shall be securely mounted on the panel door. All controls and indicators shall be 30mm, NEMA 4X/13 for outdoor panels, NEMA 4/13 for indoor panels, anodized aluminum or reinforced plastic. Booted control devices are not acceptable. Auxiliary contacts shall be provided for remote run indication and indication of each status and alarm condition. Additional controls shall be provided as specified herein and as required by the detailed mechanical and electrical equipment requirements.
b. Indicator lamps shall be LED type. For all control applications, indicator lamps shall incorporate a push-to-test feature.

c. Mode selector switches (HAND-OFF-AUTO, LOCAL-OFF-REMOTE, etc.) shall have the number of positions and contact arrangements, as required. Each switch shall have an extra dry contact for remote monitoring.

d. Panel meters for digital display of analog signal values shall be provided where indicated. Panel meters shall be 4-20mA loop powered, 1/8 DIN LCD displays, Precision Digital Model PD 6600 series or equal.

e. Panel Interface Connector (PIC): Each control panel with a PLC shall include a PIC mounted on the outside of the enclosure for providing an Ethernet connection to internal devices. The PIC shall include a 120VAC single phase duplex receptacle with 3 amperes externally resettable circuit breaker and an RJ45 pass-through connector.

f. Furnish nameplates for each device. All nameplates shall be laminated plastic, black lettering on a white background, attached with stainless steel screws. Device mounted nameplates are not acceptable.

g. The manufacturer shall not remove, reuse, alter, or replace original equipment nameplates or equipment tags associated with equipment or components supplied by the manufacturer’s suppliers and sub-suppliers.

5. Control Relays

a. Provide relays as required to implement indicated control functions. General purpose, alternating, and time delay relays may be used within their ratings for logic, timing, and sequencing but shall not be used to drive loads in excess of 80% of their contact “make” or “break” ratings. Provide interposing power relays to drive loads such as starters larger than NEMA size 1 and all other utilization equipment with loads greater than specified for general purpose and time delay relays. Provide relays rated to drive the load as required. Relays shall be provided with an LED status indicator.

b. Discrete Input/Output Relays: Terminal block style interposing relays shall be used for all controller digital inputs and outputs. Devices shall be PLC-RSC series as manufactured by Phoenix Contact or equal. Provide pull-up or pull-down resistors on all digital outputs as required for the application.

6. Control and Instrument Power Transformers

a. Control power transformers shall be provided. Transformer shall be sized for the entire load, including space heaters, plus 25% spare capacity, and shall be not less than 100VA.

b. Control power transformers shall be 120 volts grounded secondary. Primary side of the transformer shall be fused in both legs. One leg of the transformer secondary shall be solidly grounded, and the other leg shall be fused.

c. Control power transformers shall be installed inside the control panel that they serve. They shall not be mounted exterior to the panel.

7. Power Supplies

a. When required, the control panel shall be furnished with a separate DC power supply to provide DC power for control panel components and the loop power for 2-wire instruments. The power supplies shall be DIN rail mounted, 120VAC input, 24VDC output, with output load rated as required for the connected loads. Power supplies shall be provided by Phoenix Contact, Allen-Bradley, or Sola.

B. Enclosures

1. General

a. Each enclosure shall incorporate a removable back panel and side panels, on which control components shall be mounted. Back panel shall be secured to the enclosure with collar studs for wall mounted enclosures, and 316 SS hardware for free standing enclosures.

b. All free-standing enclosures shall be provided with feet of the same construction as the enclosure.
c. Back panel shall be tapped to accept all mounting screws. Self-tapping screws shall not be used to mount any components.

d. All enclosure doors shall have bonding studs. The enclosure interior shall have a bonding stud.

e. Each enclosure shall be provided with a documentation pocket on the inner door.

f. Enclosures shall not have holes or knockouts.

g. Provide manufacturer’s window kits as shown on the Drawings.

h. All enclosures shall be pad-lockable.

2. NEMA 4X

a. NEMA 4X panels shall be provided for all outdoor locations, or indoor locations where directly exposed to process or wash-down water.

b. NEMA 4X 316 Stainless Steel

c. Type 316 stainless steel, body and door

d. Stainless steel continuous hinge

e. Foam gasket

f. Single point quarter turn latches (20”x24” and below). All others: 3-point latch.

g. Manufacturers

1) Hoffman Comline Series

2) EMF Company

3) NEMA Enclosures Company

4) Hammond Company

5) Approved Equal

3. NEMA 12

a. NEMA 12 panels shall be provided for clean and dry indoor locations.

b. NEMA 12 Painted Steel.

c. Painted steel, body, and door

d. Continuous hinge

e. Foam gasket

f. Single point quarter turn latches (20”x24” and below). All others: 3-point latch.

g. Manufacturers

1) Hoffman Comline Series

2) EMF Company

3) NEMA Enclosures Company

4) Hammond Company

5) Approved Equal

C. Environmental Conditioning

1. Air Conditioning

a. A panel air conditioner shall be provided where panels include variable frequency drives and are installed outdoors or unconditioned indoor spaces.

b. The air conditioner shall be powered from the panel. A separate power source shall not be required.

c. The enclosure cooling system shall not compromise the enclosure’s NEMA rating and shall be sized for the environment in which the control panel will be installed.

d. The air conditioner shall be sized to provide cooling to maintain the interior temperature of the panel to meet VFD manufacturer recommendations for maximum ambient temperature.

2. Ventilation

a. Where air conditioning is not required, panel fans and louvers shall be provided where panels are installed in unconditioned indoor spaces.

b. Panel ventilation shall also be provided in indoor conditioned spaces where the panel manufacturer has determined it necessary in order to maintain the interior temperature of the panel within manufacturer recommended limits.

c. The fans shall be powered from the panel. A separate power source shall not be required.
d. The enclosure ventilation system shall not compromise the enclosure’s NEMA rating and shall be sized for the environment in which the control panel will be installed.
e. The ventilation shall be sized to maintain the interior temperature of the panel to meet manufacturer recommendations for maximum ambient temperature of all electronic components.

3. Condensation Control
   a. A self-contained enclosure condensation heater with thermostat and fan shall be mounted inside the control panel if panel is mounted outdoors, or in a non-air-conditioned space.
      1) Enclosure heaters shall be energized from 120-volt, single-phase power supply and sized to prevent condensation within the enclosure.
      2) Locate enclosure heaters to avoid overheating electronic hardware or producing large temperature fluctuations on the hardware.
      3) Enclosure heaters shall have an internal fan for heat distribution and shall be controlled with adjustable thermostats. The thermostat shall have an adjustment range of 40 degrees Fahrenheit to 90 degrees Fahrenheit. Provide a circuit breaker or fused disconnect switch within the enclosure.
      4) Enclosure heaters shall be Hoffman type DAH or equal.
   b. Strip heaters may be provided if they are 240-volt rated, powered at 120 volts AC and do not have a surface temperature higher than 60°C. Strip heaters and thermostats shall be as manufactured by Chromalox or equal.
   c. Each panel shall have a ½” stainless steel condensate drain.

D. Internal Wiring
   1. Power and control wiring shall be tinned stranded copper, minimum size No. 14 AWG for power wiring and No. 18 AWG for control wiring, with 600V, 90 degree C, flame retardant, Type MTW thermoplastic insulation. Line side power wiring shall be sized for the full rating or frame size of the connected device.
   2. Analog signal wires shall be 600 Volt Class, insulated stranded tinned copper, twisted shielded minimum No. 18 AWG pair.
   3. All interconnecting wires between panel mounted equipment and external equipment shall be terminated at numbered terminal blocks. Field wiring shall not be terminated directly on any panel-mounted device.
   4. All wiring shall be tagged and coded with an identification number as shown on the Drawings. Coding shall be typed on a heat shrinkable tube applied to each end showing origination and destination of each wire. The marking shall be permanent, non-smearing, solvent-resistant type, similar to Raychem TMS-SCE, or equal.
   5. All wiring shall be enclosed in PVC wire trough with slotted side openings and removable cover. Plan wire routing such that no low voltage twisted shielded pair cable conducting analog 4-20 mA signals or low voltage analog signals are routed in the same wire trough as power conductors carrying greater than 120V.
   6. All control panel wiring shall use the following color code.
      a. Black: AC power at line voltage
      b. Red: switched AC power
      c. Orange: May be energized while the main disconnect is in the off position
      d. White: AC neutral
      e. Orange/white stripe or white/orange stripe: separate derived neutral
      f. Red/white stripe or white/red stripe: switched neutral
      g. Green or green w/ yellow tracer: ground/earth ground
      h. Blue: Ungrounded DC power
      i. Blue/white stripe or white/blue stripe: DC grounded common
      j. Brown: 480VAC3 phase - phase A
      k. Orange: 480VAC3 phase - phase B
      l. Yellow: 480VAC3 Phase - phase C
      m. Purple: common for analog signal wiring
      n. Brown: positive leg of an analog signal
E. Field Installed Internal Wiring
1. Field installed interior wiring shall be neatly grouped by circuit and bound by plastic tie wraps. Circuit groups shall be supported so that circuit terminations are not stressed. In addition, low signal wiring (millivolt and milliamp) shall be bundle separately from the rest of the control wiring.
2. All field wiring shall be tagged and coded with an identification number. Coding shall be typed on a heat shrinkable tube applied to each end of the wire. The marking shall be a permanent, non-smearing, solvent-resistant type, similar to Raychem TMS-SCE, or equal.
3. In general, all conduit entering or leaving outdoor panels shall be stubbed up into the bottom of the enclosure to the greatest extent possible.

F. Terminal Blocks
1. Terminal blocks shall be DIN-rail-mounted one-piece molded plastic blocks with tubular-clamp-screw type and end barriers. Terminal blocks shall be rated for 600 volts except for control and instrumentation circuits, or 4-20 mA analog signal conductors.
2. Provide 600V rated terminal blocks for any conductor carrying any voltage over 120 volts to ground.
3. Provide 600V rated strap screw terminal blocks for any power conductors carrying over 20 amps, at any voltage. Terminals shall be double sided and supplied with removable covers to prevent accidental contact with live circuits.
4. Power conductors carrying over 20 amps, at any voltage shall be terminated to strap-screw type terminal blocks with crimp type, pre-insulated, ring-tongue lugs. Lugs shall be of the appropriate size for the terminal block screws and for the number and size of the wires terminated. Do not terminate more than one conductor in any lug, and do not land more than two conductors under any strap-screw terminal point.
5. Terminals shall have permanent, legible identification, clearly visible with the protective cover removed. Each terminal block shall have 20 percent spare terminals, but not less than two spare terminals.
6. Use the manufacturer’s provided bridge connectors to interconnect terminal blocks terminating common or ground conductors.
7. Twisted shielded pair or triad cables shall have each individual conductor and shield drain wire landed on individual terminal blocks. Use the manufacturer’s provided bridge connectors to interconnect terminal blocks terminating the shield drain wire conductors.
8. Control circuits, 120 volts and below, and 4-20 mA analog signal conductors shall be terminated with manufacturer’s recommended insulated connectors.
9. Current Loop Surge Protection Devices: The 4-20mA signal loop channels on analog inputs and outputs shall be protected against static discharge, lightning, and faulty wiring with three stage surge protection terminal block devices. Devices shall be pluggable with indication status lights. Devices shall be PLUGTRAB series as manufactured by Phoenix Contact or equal.
10. Provide an AC ground bar bonded to the panel enclosure (if metal) with 20 percent spare terminals.
11. Provided ground terminal blocks for each twisted-shielded pair drain wire.

2.3 MAIN CIRCUIT PROTECTIVE DEVICE

A. For panels operating at 480V ac, unless otherwise shown on the Drawings, the main circuit protective device shall be a molded case (MCCB), 3-Pole, 600V, fixed type, manually operated with stored energy closing mechanism. For MCCBs 200A and larger, trip device shall be solid state with adjustable long-time pickup, and delay; adjustable short-time pickup and delay; and short-time i2t switch. Provide ground fault pickups as indicated on the drawings.
1. Provide a flange mounted main power disconnect operating handle with mechanical interlock having a bypass that will allow the panel door to open only when the switch is in the OFF position. Where panels are shown or specified with inner and outer doors, disconnecting handles and controls shall be located on the inner door.
2.4 ACROSS THE LINE MOTOR CONTROLLERS

A. General
1. Provide the NEMA size starter, circuit breaker trip ratings, control power transformers, and thermal overload heater element ratings that match the actual motors and control equipment supplied, in compliance with the NEC and the manufacturer’s heater selection tables. All variations necessary to accommodate the actual motors and controls furnished shall be made without extra cost to the Owner.
2. Furnish lugs for incoming wiring. Allow adequate clearance for bending and terminating of cable size and type specified.
3. A NEMA rated magnetic motor starter shall be furnished for each motor. Each motor starter shall be provided with a motor circuit protector or circuit breaker and equipped to provide undervoltage release and overload protection on all three phases. The short circuit protective device shall have an adjustable magnetic trip range up to 1400 percent of rated continuous current and a trip test feature. MCPs shall be labeled in accordance with UL 489. NEMA starter sizes and breaker trip ratings shall be as required for the horsepower indicated but shall be in no case less than NEMA Size 1. If the manufacturer of the equipment utilizing the motor supplies a motor horsepower larger than that shown on the Drawings, the Contractor shall supply a motor starter sufficient in size to control the motor supplied.
4. A mechanical disconnect mechanism, with bypass, shall be installed on each motor circuit protector capable of being locked in the "OFF" position, to provide a means of disconnecting power to each motor. Disconnect mechanisms shall be located inside the enclosure such that the main circuit breaker handle is the only device interlocked with the panel door.
5. Each motor starter shall have a 120V operating coil unless otherwise noted.
6. Overload relays shall be electronic type with ability for remote electronic reset. A normally closed contact shall be directly used in the start circuit, and a normally open contact shall be wired to a terminal board for overload alarm.
7. All interfaces between control panel and remote devices shall be isolated via an interposing relay. Interposing relays shall have contacts rated for 250VACand 10A continuous. Relays shall be Control Relays as specified herein.

B. Magnetic Motor Starters
1. Motor starters shall be 2- or 3- pole, single- or 3- phase as required, 60Hz, 600V, magnetically operated, full-voltage non-reversing. NEMA sizes shall be as required for the horsepower shown on the Drawings.
2. Each motor starter shall have a 120V operating coil and a control power transformer. Starters shall have a motor overload protection in each phase. Auxiliary contacts shall be provided as shown on the Drawings. A minimum of one N.O. and one N.C. auxiliary contacts shall be provided in addition to the contacts required.
3. Overload relays shall be adjustable, ambient compensated, and manually reset.
4. Built-in control stations and indicating lights shall be furnished where shown on the Drawings.
5. All wires shall be terminated on terminal blocks and tagged.
6. Provide as-built wiring diagram and post it in a protective cover inside the cell.

C. Contactors
1. Contactors shall be a circuit breaker and contactor, 600V, 3-Pole, 60Hz, magnetically operated. NEMA size shall be as required for the kilowatt ratings required for the equipment provided but shall be not less than NEMA size 1.
2. Contactors shall have a 120V operating coil and control power transformer. Furnish the control power transformer with extra capacity for the unit heater fan.

D. Control Relays
1. Control relays shall be 300V, industrial rated, plug-in socket type, housed in a transparent polycarbonate dust cover, designed in accordance with UL Standard 508 for motor controller duty. Continuous contact rating shall be 10A resistive, ¼ HP at 120V ac, operating temperature minus 10 to plus 55 degrees C. Provide spare N.O. & N.C. contacts. Relays shall be Potter & Brumfield KRP Series, or equal, with neon coil indicator light. Timing relays shall be 300V, solid state type, with rotary switch to select the timing range.

E. Elapsed Time Meter
1. A six-digit, non-resettable elapsed time meter shall be installed on the face of each motor starter.

2.5 VARIABLE FREQUENCY DRIVE MOTOR CONTROLLERS
A. Where variable frequency drives (VFDs) are provided for motor starting and control, comply with requirements of Division 26 specifications for VFDs.

2.6 INSTRUMENTATION DEVICES
A. Where instrumentation devices are specified or shown on the Drawings, refer to Division 40 Instrumentation specifications.

2.7 REMOTE MONITORING AND CONTROL INTERFACE
A. General: All control and interconnection points from the equipment to the plant control and monitoring system shall be brought to dedicated terminal blocks. No field connections shall be made directly to the equipment control devices. Functions to be brought out shall be as specified in related specification sections and the contract drawings.

B. Discrete control or status functions shall be Form C relays with contacts rated at 120V ac. Analog signals shall be isolated from each other.

2.8 PROGRAMMABLE LOGIC CONTROLLERS (PLC)
1. Refer to specification 40 63 43 for PLC requirements.

2.9 OPERATOR INTERFACE DEVICES
1. Provide Rockwell Automation Panelview Plus operator interface devices where indicated on drawings and equipment specifications. All OITs shall be minimum 10” screen size.

2.10 NETWORK DEVICES
1. Ethernet Switches
   a. Switches installed in control panels shall be DIN-rail mounted managed switches with RJ-45 and fiber ports as required for the application. Provide a minimum of two (2) spare RJ-45 ports and two (2) fiber ports for future connections. Provide at least two (2) fiber ports whether or not fiber connections are required.
   b. Switches shall support gigabit connection speeds.
   c. Switches shall be Red Lion NT24k family or equal.

2.11 UNINTERRUPTIBLE POWER SUPPLY (UPS)
A. Each control panel provided with a PLC shall contain a UPS to provide seamless and continuous operation of control panel equipment during power outages. The UPS shall provide backup power meeting the following requirements:
   1. True sine wave output with on-line double conversion configuration
   2. Fault, overload, and replace batteries indicators
   3. Voltage input: 120 VAC single phase
4. Voltage output: 120VAC single phase
5. Output power capacity: 1000W / 1500VA minimum
7. Hot-swap batteries
8. UPS to be manufactured by APC, Falcon, Trip-lite, or equal.

2.12 SPARE PARTS

A. Provide the following spare parts for each control panel in the quantities specified:
   1. PLC spare modules and parts as required in specification 40 63 43 – Programmable Logic Controllers.
   2. Six replacement fuses, all types and sizes
   3. One replacement lamp, of each color, for pilot lights
   4. Replacement lens caps, of each color, for pilot lights
   5. One starter coil for each NEMA size furnished
   6. One, 3-pole set of replacement overload heaters, of each size range used
   7. One, 3-pole set of starter contacts, of each NEMA size used.

B. Spare parts shall be boxed or packaged for long term storage. Identify each item with manufacturer’s name, description, and part number on the exterior of the package.

2.13 FACTORY TESTING

A. The entire control panel shall be completely assembled, wired, and adjusted at the factory and shall be given the manufacturer’s routine shop tests and any other additional operational test to ensure the workability and reliable operation of the equipment.

B. A Factory Readiness Test shall be performed according to requirements in specification 40 61 13 – Process Control System General Provisions.

C. Factory test equipment and test methods shall conform with the latest applicable requirements of ANSI, IEEE, UL, and NEMA standards.

D. The operational test shall include the proper connection of supply and control voltage and, as far as practical, a mockup of simulated control signals and control devices shall be fed into the boards to check for proper operation.

E. Factory test equipment and test methods shall conform to the latest applicable requirements of ANSI, IEEE, UL, and NEMA standards, and shall be subject to the Owner/Engineer’s approval.

PART 3 - EXECUTION

3.1 INSTALLER’S QUALIFICATIONS

A. Installer shall be specialized in installing this type of equipment with minimum 5 years documented experience. Experience documentation shall be submitted for approval prior to beginning work on this project.

3.2 EXAMINATION

A. Examine installation area to assure there is enough clearance to install the equipment.

B. Housekeeping pads shall be included for the floor mounted motor controllers as detailed on the Drawings with the exception of motor controllers which are to be installed adjacent to an existing unit. Housekeeping pads for these (if used) should match the existing installation.
C. Check concrete pads and baseplates for uniformity and level surface.

D. Verify that the equipment is ready to install.

E. Verify field measurements are as instructed by manufacturer.

3.3 INSTALLATION

A. The Contractor shall install all equipment per the manufacturer's recommendations and Contract Drawings.

B. Install required safety labels.

C. All wiring shall be neatly installed, and wire ways shall be used wherever possible. All wiring shall be identified at all terminating locations by Tag ID as identified in Drawings.

3.4 FIELD QUALITY CONTROL

A. Inspect installed equipment for anchoring, alignment, grounding, and physical damage.

B. Check tightness of all accessible electrical connections. Minimum acceptable values are specified in manufacturer's instructions.

C. Provide one set of as-built panel drawings laminated, in each panel pocket.

3.5 FIELD ADJUSTING

A. Adjust all circuit breakers, switches, access doors, operating handles for free mechanical and electrical operation as described in manufacturer's instructions.

3.6 FIELD TESTING

A. Perform all electrical field tests recommended by the manufacturer. Disconnect all connections to solid-state equipment prior to testing.

B. Megger and record phase-to-phase and phase-to-ground insulation resistance. Megger, for 1 minute, at minimum voltage of 1000V DC. Measured Insulation resistance shall be at least 100 megohms. In no case shall the manufacturer’s maximum test voltages be exceeded.

C. Test each key interlock system for proper functioning.

D. Test all control logic before energizing the motor or equipment.

3.7 CLEANING

A. Remove all rubbish and debris from inside and around the motor controllers. Remove dirt, dust, or concrete spatter from the interior and exterior of the equipment using brushes, vacuum cleaner, or clean, lint-free rags. Do not use compressed air.

3.8 EQUIPMENT PROTECTION AND RESTORATION

A. Touch-up and restore damaged surfaces to factory finish, as approved by the manufacturer. If the damaged surface cannot be returned to factory specification, the surface shall be replaced.

END OF SECTION
SECTION 40 68 63 – PLC AND OIT PROGRAMMING

PART 1 - GENERAL

1.1 SUMMARY

A. The specification describes the work to be performed by the integrator, consisting of labor, licensing, software, and incidentals for the programming of all PLCs, OITs, and other hardware that make up the process control system. The work shall include every item of programming and configuration necessary for a complete and functioning installation as shown on the drawings and as specified herein.

B. Related Sections:
   1. 40 61 96 – Process Control Descriptions

1.2 REFERENCES


B. Definitions:  Symbols, Definitions, and Abbreviations: All symbols, definitions, and engineering unit abbreviations utilized shall conform to IEEE 100-84, S50.1, and S51.1, where applicable.
   1. SCADA – Supervisory Control and Data Acquisition
   2. HMI – Human Machine Interface
   3. OIT – Operator Interface Terminal
   4. PLC – Programmable Logic Controller
   5. I/O – Input/Output
   6. VFD – Variable Frequency Drive
   7. SSRVS – Solid State Reduced Voltage Starter ("Soft Starter")
   8. RTU – Remote Telemetry Unit
   9. MTU – Master Telemetry Unit
   10. MCC – Motor Control Center
   11. ETM – Elapsed Time Meter
   12. IOP – Integrated Operating Platform – System of installed, connected, and configured hardware, operating programs, and networking equipment
   13. PLC and OIT Programming – Software configuration of operating programs to implement plant control strategies

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 SCOPE

A. The integrator shall be responsible for design of the PLC and OIT programs to achieve process control as described by the drawings and specifications. The integrator shall fully coordinate all components and details of the control system with all other equipment on the project.

B. The integrator shall coordinate all PLC and OIT programming, testing, and startup activities with the Contractor who is responsible for all instrumentation, control, and SCADA hardware. The integrator shall coordinate required implementation schedules with the Contractor and provide on-site assistance as required throughout the duration of the project.
C. The integrator shall assist the Contractor with control panel field testing by providing PLC programming as necessary to verify all PLC I/O is properly connected and configured.

D. Before final acceptance, the integrator shall configure all control loops to achieve stable process control in all conditions, and perform a thorough test of all system functions.

E. The system shall include custom PLC programming and process screen displays developed by the integrator. The screens will provide the major vehicle for operators to monitor and interact with the treatment process. These displays shall enable speedy access and provide the capability to manipulate process control variables along with performing standard operator tasks such as ramping values and responding to alarms. User defined graphics displays shall depict specific views of the process operations and control. They shall be created and configured for monitoring and managing the process through the software.

F. Prior to finalizing graphic screens, the integrator shall submit screen captures of the proposed OIT screens to the Engineer and Owner for review. The submitted screen captures shall be sufficient to display the contents of the system, and to determine visual conformance with the Owner’s standards. The integrator shall modify the screen contents based on the Owner and Engineer review prior to functional system testing. Review of the screens at this stage is preliminary and is not a final approval of all OIT content and functionality as required by the contract documents.

3.2 GENERAL

A. All server and workstation programs required for the IOP shall be automatically started during the boot sequence.

B. All calculations shall be performed in the PLC, including but not limited to analog control point values, unit conversions, timers, and numeric manipulations.

C. All set points shall test for minimum and maximum values and shall be operator adjustable via the operator interface software.

D. Each PLC shall be configured to provide the system a heartbeat function that will enable the system to periodically check for proper communications. The OIT application shall issue an alarm if communication fails. A PLC monitoring screen shall be configured to indicate the alarm conditions and log any occurrence of an alarm with a date/time stamp and description.

E. Inputs/Outputs
1. P&ID and I/O list sheets in the drawings show the expected I/O points. Many I/O points on the input/output list are existing and are therefore not shown on the P&IDs.
2. All analog I/O shall be trended on the associated OIT.
3. Analog Inputs: Analog inputs shall be scaled, summed, logged, provided with high and low alarming with adjustable deadbands, and integrated against time for totalization as required.
4. Analog Outputs: Analog outputs shall be scaled as required.
5. Digital Inputs: Digital inputs shall be configured as status indicators or as alarms as required. As an alarm indicator, the digital indicator shall record a descriptive alarm message with the date and time of the occurrence.
6. Digital Outputs: Digital outputs shall be configured as either normally open or normally closed contacts with maintained or momentary action as may be required.

F. OIT Graphic Displays
1. Layout:
a. Header or sidebar display containing city logo, alarm indicator, and non-process related navigation objects.
b. Main process overview screens will display major equipment statuses, analog values, and alarms in a graphical P&ID format.
c. Equipment popups will allow the operator to drill down to specific motors, valves, and instruments, displaying detailed information and allowing for equipment and device control.
d. A trending screen will display up to four trend charts for analog process values.
e. An alarming screen will display an alarm log history with description, date and timestamp, and acknowledgement status of alarm.
f. An event log screen will display system event history such as user logins with date and timestamps.
g. A PLC diagnostic screen will display PLC module statuses, as well as any communication alarms. This screen will also depict the local control panel network and any connected devices (OIT, PLC, Ethernet Switches, etc.)

2. Navigation tools will be intuitive and consist of a navigation ribbon, as well as process links to adjacent displays and complexes.

G. Package Systems
1. Control and status data transmitted to and/or received from peer devices via a communications network must be performed using peer-to-peer messaging or similar method requiring only the peer devices. Peer-to-peer control data shall not be conveyed to a peer device via HMIs, OIT, servers, or workstations.
2. Coordinate control and status data interface between IOP and packaged systems with manufacturer.

H. The integrator shall furnish the Owner final as-built copies of documented PLC and OIT programs, on electronic media, suitable for future troubleshooting or modifications by others.

3.3 SECURITY
A. OIT applications shall employ security configurations to prevent unauthorized changes to control and alarm parameters.

B. At a minimum, the security configuration shall consist of the following four access levels: View, Operator, Maintenance, and Engineer. Coordinate additional access levels and restrictions with Owner.
1. Engineer: Unrestricted access to all system features and parameters.
2. Maintenance:
   a. Start and stop servers, workstations, and programs.
   b. Control loop tuning
   c. Run diagnostic programs.
   d. Process troubleshooting and repair.
   e. IOP troubleshooting and repair.
   f. Adjust process parameters.
   g. Bypass interlocks and permissives configured with bypass option.
   h. Enable and disable equipment control from PLC.
3. Operator:
   a. Start and stop OIT applications.
   b. Adjust process parameters.
4. View:
   a. OIT navigation privileges only.

C. User management shall utilize a User Configuration pop-up display with features to support adding, modifying, and deleting users. User management displays and features shall be restricted to users with Engineer privileges.
D. Password management shall utilize a pop-up display to allow users to manage their respective passwords.

E. A user shall be automatically logged out after periods of inactivity. Coordinate the time span a user must be inactive with the owner.

3.4 ALARM MANAGEMENT

A. At a minimum, each alarm in the PLC shall have the following attributes.
   1. Alarm description
   2. Alarm setpoint or logical condition
   3. Alarm priority. Alarm priorities shall be set in a manner
   4. Deadband (analog alarms)
   5. On delay
   6. Off delay
   7. Area or group
   8. Alarm message. Alarm messages shall be consistent in wording.
   9. Alarm shelving by operator
   10. Alarm suppression by program.

B. Disabled, suppressed-by design, or shelved alarms shall not impact other logic functions, such as interlock actions.

C. At a minimum, each alarm record will include the following attributes.
   1. Alarm source tag name
   2. Alarm description
   3. Alarm state
   4. Alarm Priority
   5. Alarm group
   6. Process value at time of occurrence.
   7. Time and date of alarm occurrence change of state.

D. The following alarm states will be used when displaying alarms on the OIT.
   1. Normal: No indication.
   2. Unacknowledged Alarm: Audible and visual indication of alarm condition. Indication will be easily distinguishable from other alarm states.
   3. Acknowledged Alarm: Visual indication of alarm condition. Indication will be easily distinguishable from other alarm states.

E. All alarm configurations, controls, and states will be handled in the PLC. Alarm configurations and settings will be selectable and/or adjustable via the OIT.

F. Coordinate self-healing and reset required alarms with Owner. All alarms shall be acknowledged via the OIT.

G. All alarm set-points shall be engineer adjustable from the OIT.

H. Pre-configure analog device feedback high-high, high, low, low-low, rate-of-change, and out-of-range alarms.

I. Other specific alarms are designated in the control loop descriptions.
3.5 PROCESS EQUIPMENT AND DEVICES

A. OIT graphic objects shall use color and text to indicate remote control mode, software mode, and operating states.
1. Remote control modes will include Remote and Not in Remote.
2. Software modes shall include Manual/Off/Auto modes.
   a. Manual: Operator is control owner. If equipment and/or device is in remote control, ready for operation in any mode, and interlocks are satisfied the equipment operation shall follow operator commands.
   b. Off: Equipment and/or device operation from IOP is disabled.
   c. Auto: Program is control owner. If equipment and/or device is in remote control, ready for automatic operation, interlocks are satisfied, and permissives are satisfied, the equipment operation shall follow program commands.
3. States:
   a. Machine, pump, and blower operating states shall include stopped, stopping, starting, running.
   b. Valve and gate operating states shall include closing, closed, opening, and opened.
   c. Unique colors shall be used for stopped/closed, running/closed, starting/opening, and stopping/closing states. Coordinate colors with the Owner.
4. Variable speed and variable position devices shall include actual speed and/or position as applicable.
5. Alarm indications for process objects will include an alarm border and alarm priority symbol in the color of the highest priority active, unacknowledged alarm. Additionally the alarm symbol shall include the priority value for said alarm.

B. Pop-up faceplate displays will be included for monitoring, controlling, and configuring equipment and/or devices capable of control from the OIT. Faceplates shall be accessed by a click event on the graphic object. At a minimum, faceplates shall include the following features and configured with the applicable access levels.
1. Operator:
   a. General display with 1) mode selector 2) manual speed (position) setpoint (if applicable); 3) cumulative interlocks, permissives, unit ready for automatic control status, actual state, and actual speed (if applicable).
   b. Diagnostics displays with status indications for each interlock trip, permissive trip, unit not ready trip, and fault trip.
   c. Operating statistics, such as ETMs and operation cycle counts. This display shall also include a reset button to reset total values.
2. Maintenance:
   a. Include diagnostic features including the ability to disable operation separate from any operator-adjustable features.
   b. Provide a means to bypass interlocks and permissives that are configured with a bypass feature.
3. Engineer:
   a. Include all configuration settings required to fully control unit, including but not limited to default modes, bumpless transfer, operating range, individual interlock and permissive bypassing.

C. All actuated or driven units shall include PLC logic and OIT features to calculate and display operating statistics, such as cycle counts and ETMs.
1. ETMs and cycle counters shall totalize the time and the number of times a unit is in the operating state, such as running or opened.
2. ETMs and cycle counters shall capture starts per hour, daily totals, monthly totals, and running totals for display on OIT. Running totals shall maintain values until reset via an operator-selectable reset button on the respective faceplate. Daily totals are reset at engineer-adjustable time-of-day.
3. Each ETM and cycle counter shall include provisions for users with Maintenance permissions to restore or set totalized values to a new value.

D. Equipment and/or devices with state feedback and remote control from the PLC, such as machines, valves and pumps, shall include a timeout alarm to indicate the commanded state was not achieved. Alarms for this type of failure must be reset by initiating an alarm reset from the OIT, achieving commanded state, local mode change, or software mode change.

E. Equipment and/or devices with remote control feedback to the OIT shall include an alarm to indicate when the field mode selector is not set for remote control.

3.6 PROCESS MONITORING AND CONTROL

A. Each process shall include Manual/Off/Auto modes for automatic control, overriding automatic control, and disabling OIT control.

B. Each process shall have an associated pop-up display that uses symbols, text, and color to indicate the actual process state. The following states shall be included. In some cases, not all states are required, and may be omitted as needed.
   1. Resetting, Idle, Starting, Executing, Completing, Complete
   2. Holding, Held, and Un-holding
   3. Suspending, Suspended, and Un-suspending
   4. Stopping and Stopped
   5. Aborting, Aborted, and Clearing

C. A PID pop-up display shall be provided for configuring, adjusting, and monitoring closed-loop process controls. At a minimum, PID displays shall include maintenance adjustable PID loop parameters, operator-adjustable set-point, and real time trend with set-point, process variable and control variable pens.

D. Provide alarms as required to indicate when a closed-loop process is out of control.

E. Calculate daily and monthly minimum, maximum, average and total values for each flow process variable and display values on OIT.

F. Process overview displays shall indicate the highest priority, active, unacknowledged alarm for the area. The indication shall include the following features.
   1. Alarm border with a priority symbol around the area or unit in alarm.
   2. Alarm border and priority symbol shall reflect the color associated with the alarm priority.
   3. The priority symbol shall include the priority value.

3.7 SYSTEM FUNCTIONALITY

A. The process control system shall be setup initially with the basic functionality as described in Specification 40 61 96 – Process Control Descriptions. These descriptions shall be used as a guide for controlling various items by location and the integrator shall be expected to continually refine the system functionality throughout the execution of the project. Each automatic, manual and operator initiated set point shall be configured with upper and lower limits to keep the process operating within an expected operating range. The integrator shall coordinate the functionality of each item in the control description with the Contractor, Owner and Operator. The integrator shall provide support for all functions in the OIT screens.

END OF SECTION
SECTION 40 70 00 – INSTRUMENTATION FOR PROCESS SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. The work to be included under this section of the Specifications shall consist of furnishing all materials, labor, equipment, tools, supplies, and incidentals for installation of all instrumentation equipment. The work shall include every item of construction necessary for a complete and acceptable installation as shown on the Drawings and as specified herein.

B. Related Requirements:
   1. Section 01 33 00 – Submittal Procedures
   2. Section 01 60 00 – Product Requirements

1.2 REFERENCE STANDARDS

A. ISA S20 - Specification Forms for Process Measurement and Control Instruments, Primary Elements and Control Valves

B. ISA S50.1 - Compatibility of Analog Signals for Electronic Industrial Process Instruments

C. ISA S51.1 - Process Instrumentation Terminology
   1. ISA S51.1; Sec. 5 - Test Procedures

D. NSF International:
   1. NSF 61 - Drinking Water System Components - Health Effects.
   2. NSF 372 - Drinking Water System Components - Lead Content.

1.3 COORDINATION

A. Section 01 31 00 - Administrative Requirements: Requirements for coordination.

B. Coordinate Work of this Section with piping Work.

1.4 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.

B. Product Data: Submit manufacturer information for system materials and component equipment, including connection requirements.

C. Shop Drawings:
   1. Indicate system materials and component equipment.
   2. Submit installation requirements and other details.

D. Manufacturer’s Certificate: Certify that products meet or exceed specified requirements.

E. Source Quality-Control Submittals: Indicate results of factory tests and inspections.

F. Field Quality-Control Submittals: Indicate results of Contractor-furnished tests and inspections.
G. Manufacturer Reports: Certify that equipment has been installed according to manufacturer instructions.

H. Qualifications Statement:
   1. Submit qualifications for manufacturer.

1.5 CLOSEOUT SUBMITTALS

A. Section 01 77 00 – Closeout Procedures: Requirements for submittals.

B. Project Record Documents: Record actual locations and final orientation of equipment and accessories.

1.6 QUALITY ASSURANCE

A. Ensure that materials of construction of wetted parts are compatible with process liquid.

B. Materials in Contact with Potable Water: Certified to NSF 61 and NSF 372.

1.7 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified with minimum three years of documented experience.

1.8 SOURCE QUALITY CONTROL

A. Section 01 45 00 – Quality Control: Requirements for testing, inspection, and analysis.

B. Certificate of Compliance:
   1. If manufacturer is approved by authorities having jurisdiction, submit certificate of compliance indicating Work performed at manufacturer's facility conforms to Contract Documents.

C. Similar instruments shall be by the same Manufacturer to the extent practical.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Section 01 60 00 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.

B. Inspection: Accept materials on Site in manufacturer's original packaging and inspect for damage.

C. Store equipment according to manufacturer instructions.

D. Protection:
   1. Protect materials from moisture and dust by storing in clean, dry location remote from construction operations areas.
   2. Provide additional protection according to manufacturer instructions.

1.10 WARRANTY

A. Section 01 77 00 - Execution and Closeout Requirements: Requirements for warranties.

B. Furnish a minimum one-year manufacturer's warranty for all instrumentation equipment. Refer to individual instrument specification sections for additional warranty requirements.
PART 2 - PRODUCTS

2.1 EQUIPMENT

A. Furnish instruments as specified in the individual instrument specifications. Instruments for services not listed shall be equal in quality, performance, and environmental and functional characteristics as instruments listed and shall be approved in writing by the Owner.

2.2 INSTRUMENT ACCESSORIES

A. Instrument and Control Device Tags: Each field mounted field device shall be identified by its unique tag number as it appears on the original P&I diagrams and the Instrument Loop Diagram. The tag number shall be stamped on a 1" x 2" stainless steel tag permanently attached to the instrument by braided stainless steel wire which has been sealed by an approved method such that the wire must be cut, or the seal broken to remove the tag. The tag number shall not be stamped on the nameplate of the instrument. This requirement shall be documented on the Instrumentation Specification Sheet.

B. Sunshades: Furnish stainless steel sunshades for all outdoor instruments not shaded by adjacent or integral equipment.

C. Process Tubing: Stainless Steel, ASTM A269, TP316, seamless, annealed, 1/2" x 0.065" W.T. minimum.

D. Pneumatic Supply Tubing: Stainless Steel, ASTM A269, TP316, seamless, annealed, 1/2" x 0.065" W.T., 3/8" x 0.049" W.T. and 1/4" x 0.035" W.T. minimum.

E. Fittings: 316 Stainless Steel ferrule type, SWAGELOCK or equal.

F. Pipe Stand Type Supports for Instrumentation: Pipe stands shall be stainless steel using welded fabrications with 2" schedule 40 pipe, 2" square tube x 0.188" thick, 3/8 zinc/cadmium plated hardware, 1/2" expansion anchors, 12 gauge mounting channel and 1/4" thick stainless steel plate as a minimums. Supply u-bolts or cable mounts as necessary. Acceptable alternatives include engineered pipe stand systems such as O'Brien Saddlepak.

G. Enclosures for outdoor locations: Furnish and install NEMA 4X enclosures. All outdoor enclosures with instrumentation accessible in enclosure door shall have a stainless steel sunshade.

2.3 INSTRUMENTATION CABLING

A. Instrumentation signal wiring shall meet the following requirements:
1. 16AWG minimum stranded tinned copper twisted pairs and triads as applicable for the application.
2. Color code shall be black/red pair (black/red/white triad).
3. Individually shielded with shield drain wires.
4. Insulation to be polyethylene PE or PVC.
5. Outer jacket to be black polyvinyl chloride PVC.

2.4 CALIBRATION

A. Order instruments factory-calibrated to the range indicated with calibration sheets indicating certification of traceability to National Institute of Standards and Technology (NIST). Instruments shall be ranged as indicated in the specification or as directed by Engineer.
2.5 FABRICATION
1. Materials of Construction: Provide 316 Stainless Steel for wetted and other parts unless otherwise specified.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Section 01 77 00 – Closeout Procedures: Requirements for installation examination.
B. Verify that items provided by other Sections of Work are ready to receive Work of this Section.

3.2 INSTALLATION

A. Coordinate location and orientation of instrumentation with final equipment installations.
B. Ensure that instruments are located to be easily accessible for maintenance.
C. Install sensing elements at the point of measurement and route sensing line or cable to the transmitter. Install the transmitters 4’-6” above grade or platform in an easily accessible location adjacent to the sensor location. Mount on pipe stanchion or support designed for the purpose individually or grouped with other transmitters.
D. Surge Protection
   1. 2-wire Loop Powered Instruments: Furnish and install surge protector, Emerson EDCO SS65 or equal, in each 4-20 mA current loop, adjacent to each respective instrument.
   2. 4-wire Separately Powered Instruments: Furnish and install 120VAC/24VDC combination surge protector, EDCO SLAC-12036 or equal, adjacent to each respective instrument.
E. Steel supports shall be in accordance with this Section, and all other sections and specification requirements.
F. Process connections for instrumentation shall be in accordance with piping sections and all other specification requirements.
G. Provide block valves at taps for pressure or sampling sensor lines. Provide plugged tees at taps suitable for rodding or blowing out taps. Make pipe taps with weld-o-let type fittings or equal. Install block valves suitable for the service and rated as the pipe at each tap, generally use NPT threaded ball valves. Use materials rated for the service and transition to tubing for sensor runs. Use 1/2” OD 316 SS tubing or as shown on the Drawing details.
H. Tubing and Fittings:
   1. Install tubing and fittings in a neat, orderly and functional manner; level and plumb except as required, noted on approved drawings, or specified. Make offsets required for fittings or equipment level in the horizontal plane to prevent high or low spots.
I. Conduit and fittings:
   1. Install conduit as required. Provide a cast body tee fitting at the instrument connections at the low point of all conduit runs below the instrument with a drain fitting for condensate. Make connections from instrument to tee with liquid-tight flexible conduit and use sealing compound inside the conduit and shrink-fit tubing over the outside of the connection to prevent entry of water into the instrument. Heat trace and insulate all liquid filled lines and the sensing body of all instruments connected to liquid service in exterior locations.
J. Calibration
1. Calibrate every instrument connected to the work of this contract in its range, whether furnished under this contract, Owner-furnished, or existing, and fill out a signed and dated five-point calibration sheet and install an initialed and dated calibration sticker. Notify the Owner in writing immediately of any instrument which will not calibrate. Instruments that do not calibrate will require the on-site services of a factory authorized representative at no cost to the Owner.

3.3 FIELD QUALITY CONTROL

A. Section 01 45 00 - Quality Control: Requirements for inspecting and testing.

B. Testing:
   1. Test and calibrate instruments to demonstrate that they meet specified accuracy requirements.

C. Manufacturer Services: Furnish services of manufacturer’s representative experienced in installation of products furnished under this Section, for not less than 1 day on Site for installation, inspection, startup, field testing, and instructing Owner’s personnel in operation and maintenance of equipment.

D. Equipment Acceptance:
   1. Adjust, repair, modify, or replace components failing to perform as specified and rerun tests.
   2. Make final adjustments to equipment under direction of manufacturer’s representative.

E. Furnish installation certificate from equipment manufacturer’s representative attesting that equipment has been properly installed and is ready for startup and testing.

3.4 DEMONSTRATION

A. Section 01 77 00 – Closeout Procedures: Requirements for demonstration and training.

B. Demonstrate equipment startup, shutdown, routine maintenance, and emergency repair procedures to Owner’s personnel.

END OF SECTION
SECTION 40 71 63 – ULTRASONIC FLOW METERS

PART 1 - GENERAL

1.1 SUMMARY
   A. Section Includes:
      1. Ultrasonic flow meters.
      2. Transmitters.
   B. Related Requirements:
      1. Section 40 70 00 – Instrumentation for Process Systems
   C. ASME International:

1.2 COORDINATION
   A. Refer to Specification 40 70 00 for requirements.

1.3 SUBMITTALS
   A. Refer to Specification 40 70 00 for requirements.

1.4 CLOSEOUT SUBMITTALS
   A. Refer to Specification 40 70 00 for requirements.

1.5 DELIVERY, STORAGE, AND HANDLING
   A. Refer to Specification 40 70 00 for requirements.

1.6 WARRANTY
   A. Furnish five-year manufacturer’s warranty for magnetic flow meters and appurtenant devices.

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION
   A. Furnish sensors, transmitters, and interconnecting cables as required for application.

2.2 MAGNETIC FLOW METERS
   A. Manufacturers:
      1. Flexim
   B. Description: Clamp-on ultrasonic-type flow meter, producing a linear signal directly proportional to flow rate, consisting of ultrasonic sensors, clamps, signal cable, and transmitter.
   C. Performance and Design Criteria:
      1. Design: According to AWWA M33.
   D. Flow Rate Range: As indicated in schedule.
E. Size: As indicated on Drawings.

F. Accuracy: Plus or minus 3 percent of actual flow rate.

G. Provide adjustment for zero and span.

H. Accessories:
   1. Clamping mechanism.
   2. Furnish cable between transmitter and receiver.

2.3 TRANSMITTERS

A. Transmitter Output:
   1. 4- to 20-mA DC analog signal.
   2. Accuracy: Plus or minus 0.2 percent of full scale.

B. Power Supply: 120V ac, 60 Hz.

C. Housing Material: IP67 or NEMA 4X.

D. Hazardous Location Rating: Class I Division 2.

E. HMI:
   1. Touch-screen programming.
   2. Display:
      a. Backlit graphical LCD display.
      b. Key touch programming
      c. User-selectable engineering units.
      d. Readout of diagnostic error messages.
      e. Sun shield cover for LCD display.

F. Mounting:
   1. Integral or remote mounting from flow meter as shown on Drawings.
   2. Mounting Locations Less Than 4 Feet above Grade: Provide stainless-steel mounting posts.

G. Accessories:
   1. Self-diagnostics.
   2. Automatic zero adjustment.
   3. Sunshield.
   4. Signal Cable: Provided by flow meter manufacturer.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Refer to Specification 40 70 00 for requirements.

3.2 INSTALLATION

A. Mount ultrasonic flowmeters according to manufacturer's instructions.

B. Refer to Specification 40 70 00 for additional requirements.
3.3 FIELD QUALITY CONTROL

A. Testing:
   1. Test and calibrate flow meter to demonstrate that it meets specified accuracy requirements.
   2. Comply with AWWA M6.

B. Refer to Specification 40 70 00 for additional requirements.

3.4 DEMONSTRATION

A. Refer to Specification 40 70 00 for requirements.

3.5 ATTACHMENTS

A. Flow Meter Schedule:

<table>
<thead>
<tr>
<th>Instrument Tag</th>
<th>Application</th>
<th>UL Classified</th>
<th>Measurement Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>10FIT101</td>
<td>Process Train Splitter Box #1 Flow 1</td>
<td>Class 1, Division 2</td>
<td>0-15000 gpm</td>
</tr>
<tr>
<td>10FIT201</td>
<td>Process Train Splitter Box #2 Flow 2</td>
<td>Class 1, Division 2</td>
<td>0-15000 gpm</td>
</tr>
<tr>
<td>10FIT301</td>
<td>Train A Flow</td>
<td>Class 1, Division 2</td>
<td>0-14000 gpm</td>
</tr>
<tr>
<td>50FIT201</td>
<td>WAS Flow</td>
<td>Class 1, Division 2</td>
<td>0-2000 gpm</td>
</tr>
<tr>
<td>50FIT101</td>
<td>RAS Flow</td>
<td>Class 1, Division 2</td>
<td>0-15000 gpm</td>
</tr>
</tbody>
</table>

END OF SECTION
SECTION 40 72 13 - ULTRASONIC LEVEL METERS (CONTINUOUS AND POINT TYPE)

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Ultrasonic-level measurement devices.
   2. Transmitters.

B. Related Requirements:
   1. Section 40 70 00 – Instrumentation for Process Systems

1.2 REFERENCE STANDARDS

A. National Electrical Manufacturers Association:
   1. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).

1.3 COORDINATION

A. Refer to Specification 40 70 00 for requirements.

1.4 SUBMITTALS

A. Refer to Specification 40 70 00 for requirements.

1.5 CLOSEOUT SUBMITTALS

A. Refer to Specification 40 70 00 for requirements.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Refer to Specification 40 70 00 for requirements.

1.7 WARRANTY

A. Furnish five-year manufacturer's warranty for ultrasonic level meters and appurtenant devices.

PART 2 - PRODUCTS

2.1 ULTRASONIC LEVEL MEASUREMENT DEVICES

A. Manufacturers:
   1. Siemens Automation Technology.
      a. Echomax XPS transducer
      b. Sitrans LT500 transmitter
   2. Or equal.

B. Description:
   1. Measuring Range: As indicated in schedule.
   2. Operating Temperature Range: Minus 5 to plus 140 degrees F.
   3. For scum pump applications, transmitter shall be capable of duplex duty/standby pump control based on measured level.

C. Operation: Menu guided.
D. Transmitters:
1. Selected by sensor manufacturer to match sensor.
2. Visual Display: Four digit minimum.
3. Input Signals
   a. Two (2) channel input for applications where multiple sensors are shown connected to a single transmitter.
4. Output Signals
   a. 4- to 20-mA DC for each measured level signal.
   b. Two (2) discrete output contacts for duplex pump control applications.
5. Location: As indicated on Drawings.
6. Control Power:
   a. 120-V ac, single phase, 60 Hz.
7. Enclosures: NEMA 250 Type 4X.
8. Mounting:
   a. As shown on the drawings.
9. Furnish cable, field preamplifiers, and signal conditioners as required to maintain accuracy from sensor to terminal device.

PART 3 - EXECUTION

3.1 EXAMINATION
A. Refer to Specification 40 70 00 for requirements.

3.2 INSTALLATION
A. Refer to Specification 40 70 00 for requirements.

3.3 FIELD QUALITY CONTROL
A. Testing:
   1. Test and calibrate meter to demonstrate that it meets specified accuracy requirements.
B. Refer to Specification 40 70 00 for additional requirements.

3.4 DEMONSTRATION
A. Refer to Specification 40 70 00 for requirements.
3.5 ATTACHMENTS

A. Ultrasonic Level Meter Schedule:

<table>
<thead>
<tr>
<th>Instrument Tag</th>
<th>Application</th>
<th>Measurement Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>10LIT101 Sensor(s): 10LE101, 10LE102</td>
<td>Screen Channel 1 Upstream and Downstream Levels</td>
<td>0-6 ft</td>
</tr>
<tr>
<td>10LIT201 Sensor(s): 10LE201, 10LE202</td>
<td>Screen Channel 2 Upstream and Downstream Levels</td>
<td>0-6 ft</td>
</tr>
<tr>
<td>10LIT301 Sensor(s): 10LE301, 10LE302</td>
<td>Screen Channel 3 Upstream and Downstream Levels</td>
<td>0-6 ft</td>
</tr>
<tr>
<td>10LIT401 Sensor(s): 10LE401, 10LE402</td>
<td>Screen Channel 4 Upstream and Downstream Levels</td>
<td>0-6 ft</td>
</tr>
<tr>
<td>50LIT001 Sensor(s): 50LE001</td>
<td>RAS/WAS Wetwell #1 Level</td>
<td>0-25 ft</td>
</tr>
<tr>
<td>50LIT002 Sensor(s): 50LE002</td>
<td>RAS/WAS Wetwell #2 Level</td>
<td>0-25 ft</td>
</tr>
</tbody>
</table>

END OF SECTION
SECTION 40 72 23 - RADAR LEVEL METERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Radar-level measurement devices.
   2. Transmitters.

B. Related Requirements:
   1. Section 40 70 00 – Instrumentation for Process Systems

1.2 REFERENCE STANDARDS

A. International Electrotechnical Commission:
   2. IEC 61511 - Corrigendum 1 - Functional safety - Safety instrumented systems for the process industry sector.

B. National Electrical Manufacturers Association:
   1. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).

1.3 COORDINATION

A. Refer to Specification 40 70 00 for requirements.

1.4 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.

B. Product Data: Submit manufacturer information for system materials and component equipment, including connection requirements.

C. Shop Drawings:
   1. Indicate system materials and component equipment.
   2. Submit installation requirements and other details.

D. Manufacturer’s Certificate: Certify that products meet or exceed specified requirements.

E. Source Quality-Control Submittals: Indicate results of factory tests and inspections.

F. Field Quality-Control Submittals: Indicate results of Contractor-furnished tests and inspections.

G. Manufacturer Reports: Certify that equipment has been installed according to manufacturer instructions.

H. Qualifications Statement:
   1. Submit qualifications for manufacturer.
1.5 CLOSEOUT SUBMITTALS
   A. Section 01 77 00 – Closeout Procedures: Requirements for Closeout Submittals
   B. Project Record Documents: Record actual locations and final orientation of equipment and accessories.

1.6 QUALITY ASSURANCE
   A. Test and calibrate meter to demonstrate that it meets specified accuracy requirements.
   B. Refer to Specification 40 70 00 for additional requirements.

1.7 QUALIFICATIONS
   A. Refer to Specification 40 70 00 for requirements.

1.8 DELIVERY, STORAGE, AND HANDLING
   A. Section 01 60 00 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.
   B. Inspection: Accept materials on Site in manufacturer's original packaging and inspect for damage.
   C. Store materials according to manufacturer instructions.
   D. Protection:
      1. Protect materials from moisture and dust by storing in clean, dry location remote from construction operations areas.
      2. Provide additional protection according to manufacturer instructions.

1.9 WARRANTY
   A. Section 01 77 00 – Closeout Procedures: Requirements for warranties.
   B. Furnish five-year manufacturer's warranty for radar-level measurement devices.

PART 2 - PRODUCTS

2.1 RADAR-LEVEL MEASUREMENT DEVICES
   A. Manufacturers:
      1. Vega
      2. Siemens
      3. Endress & Hauser, Inc.
      4. Rosemount
      5. Approved Equal
   B. Description:
      1. Measuring Range: Up to 66 feet.
      2. Operating Temperature Range: Minus 40 to plus 176 degrees F.
      3. Operating Pressure: Up to 580 psig.
      4. Accuracy: Plus or minus 0.4 inch.
C. Communications Protocol: HART
D. Operation: Menu guided.
E. Transmitters:
   1. Selected by sensor manufacturer to match sensor.
   2. Visual Display: LCD
   3. Input Signals
      a. Two (2) channel input for applications where multiple sensors are shown connected to a single transmitter.
   4. Output Signals
      a. 4- to 20-mA DC for each measured level signal.
      b. Two (2) discrete output contacts for duplex pump control applications.
   5. Location: As indicated on Drawings.
   6. Control Power: 120-V ac, single phase, 60 Hz or 24VDC loop powered. Coordinate with drawings.
   7. Enclosure: NEMA 4X.
   8. Mounting: As shown on the drawings.
   9. Furnish cable, field preamplifiers, and signal conditioners as required to maintain accuracy from sensor to terminal device.

2.2 SOURCE QUALITY CONTROL

A. Section 01 45 00 – Quality Control: Requirements for testing, inspection, and analysis.
B. Provide shop inspection and testing of completed assembly.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Section 01 75 60 – Testing, Training, and Facility Start-Up: Requirements for installation examination.
B. Verify that items provided by other Sections of Work are ready to receive Work of this Section.

3.2 INSTALLATION

A. Coordinate location and orientation of level probe assemblies with final equipment installations.
B. Ensure that instruments are located to be easily accessible for maintenance.

3.3 FIELD QUALITY CONTROL

A. Section 01 75 60 - Execution and Closeout Requirements: Requirements for testing, adjusting, and balancing.
B. Manufacturer Services: Furnish services of manufacturer's representative experienced in installation of products furnished under this Section for not less than 1 day on Site for installation, inspection, field testing, and instructing Owner's personnel in maintenance of equipment.
C. Equipment Acceptance:
1. Adjust, repair, modify, or replace components failing to perform as specified and rerun tests.
2. Make final adjustments to equipment under direction of manufacturer's representative.

D. Furnish installation certificate from equipment manufacturer’s representative attesting that equipment has been properly installed and is ready for startup and testing.

3.4 DEMONSTRATION

A. Section 01 79 00 – Demonstration and Training

B. Demonstrate equipment startup, shutdown, routine maintenance, and emergency repair procedures to Owner’s personnel.

3.5 ATTACHMENTS

A. Ultrasonic Level Meter Schedule:

<table>
<thead>
<tr>
<th>Instrument Tag</th>
<th>Application</th>
<th>Measurement Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>40LIT501</td>
<td>Final Clarifier #5 Scum Pit</td>
<td>0-20 ft</td>
</tr>
</tbody>
</table>

END OF SECTION
SECTION 40 72 76 - LEVEL SWITCHES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Float switches.

B. Related Requirements:
   1. Section 26 05 03 - Equipment Wiring Connections: Control power wiring requirements.
   2. Section 40 70 00 – Instrumentation for Process Systems

1.2 REFERENCE STANDARDS

A. National Electrical Manufacturers Association:
   1. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).
   2. NEMA ICS 1 - Industrial Control and Systems: General Requirements.

1.3 COORDINATION

A. Refer to Specification 40 70 00 for requirements.

1.4 SUBMITTALS

A. Refer to Specification 40 70 00 for requirements.

1.5 CLOSEOUT SUBMITTALS

A. Refer to Specification 40 70 00 for requirements.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Refer to Specification 40 70 00 for requirements.

1.7 WARRANTY

A. Furnish one-year manufacturer's warranty for level switches.

PART 2 - PRODUCTS

2.1 FLOAT SWITCHES

A. Manufacturers:
   1. Siemens.
   2. Anchor Scientific.
   3. Madison
   4. Or equal.

B. Type: Direct acting tilt float switch.

C. Materials:
   1. Rigid, Teflon coated.
   2. Mercury free.
D. Electrical:
   1. Contacts:
      a. One normally open or normally closed contact, as indicated on the drawings.
      b. Rated 1 amp, 120V AC minimum.

E. Furnished with required length of cable and weight kit for cable suspension, as required.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Refer to Specification 40 70 00 for requirements.

3.2 INSTALLATION

A. Refer to Specification 40 70 00 for requirements.

3.3 FIELD QUALITY CONTROL

A. Refer to Specification 40 70 00 for requirements.

3.4 DEMONSTRATION

A. Refer to Specification 40 70 00 for requirements.

3.5 ATTACHMENTS

A. Float Switch Schedule:

<table>
<thead>
<tr>
<th>Instrument Tag</th>
<th>Application</th>
<th>Initial Setpoint</th>
</tr>
</thead>
<tbody>
<tr>
<td>40LSL501</td>
<td>Scum Pit Low Level Cutoff</td>
<td>2.0 ft</td>
</tr>
<tr>
<td>50LSL001</td>
<td>RAS/WAS Wetwell #1 Low Level Cutoff</td>
<td>5.0 ft</td>
</tr>
<tr>
<td>50LSL002</td>
<td>RAS/WAS Wetwell #2 Low Level Cutoff</td>
<td>5.0 ft</td>
</tr>
<tr>
<td>50LSH001</td>
<td>RAS/WAS Wetwell #1 High Level</td>
<td>12.0 ft</td>
</tr>
<tr>
<td>50LSH002</td>
<td>RAS/WAS Wetwell #2 High Level</td>
<td>12.0 ft</td>
</tr>
</tbody>
</table>

END OF SECTION
SECTION 40 73 13 - PRESSURE AND DIFFERENTIAL PRESSURE GAUGES

PART 1 - GENERAL

1.1 SUMMARY
   A. Section Includes: Pressure gauges.
   B. Related Requirements:
      1. Section 40 70 00 – Instrumentation for Process Systems

1.2 REFERENCE STANDARDS
   A. ASME International:
      1. ASME B40.100 - Pressure Gauges and Gauge Attachments.
   B. NSF International:
      1. NSF 61 - Drinking Water System Components - Health Effects.
      2. NSF 372 - Drinking Water System Components - Lead Content.

1.3 COORDINATION
   A. Refer to Specification 40 70 00 for requirements.

1.4 SUBMITTALS
   A. Refer to Specification 40 70 00 for requirements.

1.5 CLOSEOUT SUBMITTALS
   A. Refer to Specification 40 70 00 for requirements.

1.6 DELIVERY, STORAGE, AND HANDLING
   A. Refer to Specification 40 70 00 for requirements.

1.7 WARRANTY
   A. Furnish five-year manufacturer's warranty for pressure gauges.

1.8 SPARE PARTS
   A. Gauges Other Than Diaphragm Protected: Furnish 20 percent spare gauges, with a minimum of one gauge for each range used.
   B. Diaphragm-Protected Gauges: Furnish 20 percent spare gauges, with a minimum of one gauge for each range used, complete with diaphragm seals.

PART 2 - PRODUCTS

2.1 PRESSURE GAUGES
   A. Manufacturers:
      1. Ametek U.S. Gauge
      2. Ashcroft, Inc.
3. Omega Engineering, Inc.
4. Wika

B. Dials:
1. Nominal Diameter: 6 inches.
2. Face: White, laminated plastic dials with black graduations.
3. Scale: Extend over arc not less than 270 degrees.
4. Ranges and Graduation Units: As indicated on pressure gauge schedule.

C. Cases:
1. Liquid filled.
3. Type: Blowout protected.
4. Provide removable rear plate.
5. Windows:
   b. Thickness: 1/8 inch.
   c. Provide gasket.

D. Connection:
1. Location: Bottom.
2. Socket:
   a. 1/4-inch or ½-inch NPT male thread.
   b. Material: Brass forging.
   c. Extend minimum 1-1/4 inches below gauge cases.
   d. Provide wrench flats.
3. Mounting: As indicated on Drawings.

E. Measuring Element:
1. Bourdon Tubes:
   b. Provide welded, stress-relieved joints.
2. Movement:
   a. Rotary geared.
   b. Material: Stainless steel.
3. Accuracy:
   a. Comply with ASME B40.100.
   b. Plus and minus 0.5 percent of full-scale range.

F. Adjustment:
1. Provide for zero-reading adjustment.
2. Adjusting Screws: Accessible from rear of case without need for disassembly.

G. Accessories:
1. Pressure Snubber:
   a. Material: Type 316 stainless steel.
   b. Provide isolation valve.
2. Shutoff Cocks: Furnished by gauge manufacturer.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Refer to Specification 40 70 00 for requirements.
3.2 INSTALLATION

A. Coordinate location and orientation of gauges and seal assemblies with final piping and equipment installations.

B. Ensure that gauges are located to be easily read during operation and easily accessible for maintenance.

C. Where a 90-degree fitting is required, install a tee-fitting with a plug.

D. Refer to Specification 40 70 00 for additional requirements.

3.3 FIELD QUALITY CONTROL

A. Refer to Specification 40 70 00 for requirements.

3.4 DEMONSTRATION

A. Refer to Specification 40 70 00 for requirements.

3.5 ATTACHMENTS

A. Pressure Gauge Schedule:

<table>
<thead>
<tr>
<th>Instrument Tag</th>
<th>Application</th>
<th>Measurement Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>40PI502</td>
<td>Final Clarifier Scum Pressure Indicator</td>
<td>0-15 psi</td>
</tr>
<tr>
<td>40PI503</td>
<td>Final Clarifier Scum Pressure Indicator</td>
<td>0-15 psi</td>
</tr>
<tr>
<td>50PI101</td>
<td>WAS Pressure Indicator</td>
<td>0-40 psi</td>
</tr>
<tr>
<td>50PI203</td>
<td>WAS Pressure Indicator</td>
<td>0-40 psi</td>
</tr>
<tr>
<td>50PI102</td>
<td>RAS Pressure Indicator</td>
<td>0-35 psi</td>
</tr>
<tr>
<td>50PI103</td>
<td>RAS Pressure Indicator</td>
<td>0-35 psi</td>
</tr>
<tr>
<td>50PI201</td>
<td>RAS Pressure Indicator</td>
<td>0-35 psi</td>
</tr>
<tr>
<td>50PI202</td>
<td>RAS Pressure Indicator</td>
<td>0-35 psi</td>
</tr>
</tbody>
</table>

END OF SECTION
SECTION 40 92 13 - MOTORIZED OPERATORS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes: Motorized gate and valve operators and mechanical, gear type limit switches.

B. Related sections:
1. Section 01 33 00 – Submittal Procedures.
2. Section 01 60 00 – Product Requirements.

1.2 GENERAL

A. Certain operators are specified in Division 44 to be furnished by equipment manufacturer as part of their equipment package and/or system. These operators are to be installed by the Contractor as specified herein. In addition to installation, the Contractor shall be responsible for test, inspection, and assisting the equipment suppliers in start-up services as required to the place the operators into continuous, reliable operation.

1.3 SCHEDULES

A. Operator schedules are contained within the Process Valve Schedules in Section 40 23 43, PROCESS VALVES.

1.4 REFERENCES

A. American Water Works Association (AWWA).

B. National Electrical Manufacturer’s Association (NEMA)

1.5 SUBMITTALS

A. Submittals shall be made as required in Section 01 33 00, SUBMITTALS of Division 01, GENERAL REQUIREMENTS. The following specific information shall be provided:

1. Design Data:
   a. Product data sheets for make and model.
   b. Complete catalog information, descriptive literature, specifications, and identification of materials of construction.
   c. Operating torque calculations for each valve size and class.
   d. Maximum starting and normal operating torques for the operators supplied. Size operator for maximum starting torque.

2. Quality Control Submittals:
   a. Tests and inspection data.
   b. Manufacturer’s Certificate of Proper Installation.
   c. Manufacturer’s printed installation instructions.
   d. Special shipping, storage and protection, and handling instructions.
   e. Suggested spare parts list to maintain the equipment in service for a period of 5 years. Include a list of special tools required for checking, testing, parts replacement, and maintenance with current price information.
   f. List special tools, materials, and supplies furnished with equipment for use prior to and during startup and for future maintenance.
1.6 QUALITY ASSURANCE

A. Ascertain that the valve manufacturer provides limit switches with the valves.

B. Actuator/operator manufacturer shall coordinate with the valve manufacturer and submit calculations showing the maximum and normal operating torques for the valves and operators supplied.

PART 2 - PRODUCTS

2.1 MOTORIZED OPERATOR

A. Manufacturers: Motorized operators for gates and valves shall be the product of a single supplier for each type of gate or valve. Products shall be furnished by one of the following, or engineer approved equal:
   1. AUMA
   2. Limitorque Company, Model MX.
   3. EIM Company.

B. Design:
   1. Sized to move gates or valves from full open to closed position at minimum 12 inches per minute, plus or minus 10 percent, under maximum load.
      a. Measure rate of closure for butterfly valve discs at disc edge on diameter at right angle to valve shaft.
   2. Actuator: Provide with built-in device to allow motor to reach full speed before engaging valve load; in manual operating mode when motor is not energized; in electrical operating mode when motor is energized.
   3. Handwheels for Manual Operation: Metallic with arrows to indicate “open” rotation; incapable of rotation during motor operation; unaffected by fused motor; maximum 80 pound pull on rim when rotating.

C. Actuator Gearing:
   1. Valve Actuator Gearing: Multiple reduction type with hardened alloy steel spur or helical gears and self-locking, alloy bronze worm gear set in drive train to maintain valve position.
   2. Gate Actuator Gearing: Multiple reduction type with hardened alloy steel spur gear, bevel pinion and bevel gears; self-locking to maintain gate position.
   3. Power Gearing: Hardened alloy steel; accurately cut to assure minimum backlash; anti-friction bearing with caged balls or rollers throughout.
   4. Stem Nuts: High tensile manganese bronze; accurately machined and mounted in heavy ball or roller bearings; minimum 2-1/4 times stem diameter for length of thread in lift nuts.
   5. Actuator Gear Housing: Ductile iron.
   6. Lubrication: Rotating power train components immersed in grease with provisions for inspection and re-lubrication without disassembly.
      a. Lubricants: Suitable for ambient conditions of minus 20 degrees Fahrenheit to plus 150 degrees Fahrenheit.
      b. Provide seals on shafting.

D. Motors:
   1. Type: Specifically designed for valve actuator service with high starting torque, totally enclosed non-ventilated construction.
   2. Motor Insulation: Minimum NEMA Class F, with a maximum continuous temperature rating of 155 degrees Centigrade, rise plus ambient.
4. Size: Sufficient to open and close valves at maximum stated torque.
5. Voltage Tolerance: Capable of operating at within 10 percent of specified voltage.
6. Motor Duty Ratings: 15 minute duty rating for open and close service; continuous duty rating for modulating service.
7. Accessories: Internal thermal contacts, heaters in motor and switch compartment, and ground lug.
8. Power Supply: As scheduled or as indicated on the Drawings.
9. Enclosures for Motors, Switches, and Other Electrical Compartments:
   a. Where explosion-proof construction is indicated on the Drawings, provide NEMA 7 enclosures.
   b. Other Locations: Provide NEMA 4X enclosures.

E. Controls:
1. Voltage Transformer: As required to step down power supply to control voltage.
2. Control Station:
   a. Integral with operator or mounted in separate enclosure.
      1) Where explosion-proof construction is indicated on the Drawings, provide NEMA 7 enclosure.
      2) For other locations, provide NEMA 4X enclosure.
   b. Provide with additional contacts for remote indication of hand switch position where indicated on the Drawings.
   c. Provide with the following devices:
      1) Lock-out ON-OFF-REMOTE selector switch.
      2) OPEN, STOP, CLOSE pushbuttons.
      3) OPEN and CLOSE indicating lights.
3. Limit switches and associated gearing shall be integral with valve actuator.
   a. Gearing: Intermittent type; bronze or stainless steel; grease lubricated; totally enclosed.
   b. Contacts: Heavy duty and silver plated with wiping action.
   c. Remote Indication Contacts: As indicated on the Drawings.
   d. Switches: Adjustable; allowing for trip points from fully open to closed positions of valve travel; not subject to breakage or slippage due to over-travel; permits visible verification of switch position without disassembly.
4. Torque Limit Switch:
   a. Capable of interrupting control circuit in both opening and closing when valve torque overload occurs.
   b. Silver plated contacts.
   c. Graduated dials for both open and close directions of travel, each independently adjustable.
   d. Positive means to limit adjustability to avoid exceeding actuator output torque capability with Belleville activating spring pack.
   e. Permits visible verification of switch position without disassembly.

F. Operation:
1. Open-Close Service:
   a. Operators shall operate automatically by remote signal specified and as indicated on the Drawings.
   b. When the selector switch is in the REMOTE position, the self-contained electromechanical reversing starter shall cause valve or gate to open or close on receiving a remote signal.
   c. When the selector switch is in the ON position, the local control station will control the motorized operator.
2. Modulating Service:
   a. Actuator Controller: Microprocessor based and using proportional-integral derivative algorithm to calculate actuator response.
b. Controller shall compare 4 to 20 milliampere direct-current analog command signal to analog feedback signal and move actuator accordingly.

c. A microprocessor-based controller shall control the integrally mounted solid state reversing starter.

3. Where indicated on the Drawings, provide 4 to 20 milliampere direct-current analog output signal for continuous remote monitoring of position.


G. Valve Limit Switches:

1. Type: Mechanical cam gear for remote operation, indication, and other control; compatible with associated operation and suitable for service intended; for valves specified and indicated on the Drawings; with racks, gears, cam, linkage mountings, and accessories.

2. Mechanical Limit Switches: 2-pole, 3-pole, or 4-pole; gang-mounted in required multiples, and with necessary mechanical linkage.

3. Contact Ratings: 120 volt alternating current, 20 amperes at 75 to 100 percent power factor, and 24 volt direct current, 5 amperes minimum.

4. Enclosures: Watertight and oiltight for normal service.

5. Valve box: Large enough to contain and to allow easy adjustment of limit switch without switch’s removal.

PART 3 - EXECUTION

3.1 SHIPPING, STORAGE, HANDLING, AND PROTECTION

A. As specified in Section 01 60 00, PRODUCT REQUIREMENTS.

3.2 INSTALLATION

A. Install operators in accordance with Manufacturer’s instructions.

B. Locate valve boxes where indicated on the Drawings.

END OF SECTION
PART 1 - GENERAL

1.1 SUMMARY

A. Section includes:
1. Valve and Gate Operators.
2. Handwheel Operators.
3. Key Operated Valves.
4. Bench Stands.
5. Floor Stands.
6. Accessory Equipment and Floor Boxes

B. Related sections:
1. Section 01 33 00 – Submittal Procedures.
2. Section 01 60 00 – Product Requirements.
3. Section 01 78 23 – Operation and Maintenance Data.

1.2 GENERAL

A. Certain valve operators are specified in Division 44 to be furnished by equipment manufacturer as part of their equipment package and/or system. These valve operators are to be installed by the Contractor as specified herein. In addition to installation, the Contractor shall be responsible for test, inspection, and assisting the equipment suppliers in start-up services as required to the place the valve operators into continuous, reliable operation.

1.3 SCHEDULES

A. Operator schedules are combined with Process Valve Schedules in section 40 23 43, PROCESS VALVES.

1.4 REFERENCES

A. Aluminum Association (AA)
1. DAF-45 – Design for Aluminum Finishes

1.5 SUBMITTALS

A. Submittals shall be made as required in Section 01 33 00, SUBMITTALS of Division 01, GENERAL REQUIREMENTS. The following specific information shall be provided:
1. Shop Drawings:
   a. Product data sheets for make and model.
   b. Complete catalog information, descriptive literature, specifications, and identification of materials of construction.
   c. Power and control wiring diagrams, including terminals and numbers.
   d. Complete motor nameplate data.
   e. Open/close and throttle actuators sizing calculations including factor of safety used and final torques used for actuation selection.
   f. Refer to specific valve type for additional submittal requirements.
2. Quality Control Submittals:
   a. Special shipping, storage and protection, and handling instructions.
b. Suggested spare parts list to maintain the equipment in service for a period of 5 years. Include a list of special tools required for checking, testing, parts replacement, and maintenance with current price information.

c. List special tools, materials, and supplies furnished with equipment for use prior to and during startup and for future maintenance.

1.6 OPERATION AND MAINTENANCE DATA

A. O&M Manuals: Content, format, and schedule for providing as specified in Section 01 78 23, OPERATION AND MAINTENANCE DATA.

B. Maintenance Summary Forms: As specified in Section 01 78 23, OPERATION AND MAINTENANCE DATA.

1.7 QUALITY ASSURANCE

A. Provide valve operators integral with the valve or gate, except for valve operators utilizing T-wrenches or keys, and portable operators intended to operate more than 1 valve.

B. Provide all similar operators by 1 manufacturer.

C. Provide gates and hand operating lifts by 1 manufacturer.

D. Provide hydraulic gate lifts by 1 manufacturer.

E. Provide hydraulic valve operators and motorized operators by 1 manufacturer.

1.8 MAINTENANCE

A. Extra materials:
   1. Key Operated Valve Keys or Wrenches: Furnish a minimum of 4 keys with 4 foot shafts and 3 foot pipe handles or wrenches with 4 foot shafts and 3 foot handles for operating key operated valves.

PART 2 - PRODUCTS

2.1 GENERAL

A. Size operator to operate valve for the full range of pressures and velocities.

B. Valve to open by turning counterclockwise.

C. Factory-mount the operator, actuator, and accessories.

2.2 VALVE OPERATORS

A. Manual Operator:
   1. General:
      a. Operator force not to exceed 40 pounds under any operating condition, including initial breakaway, and gear reduction operator when force exceeds 40 pounds.
      b. Operator self-locking type or equipped with self-locking device.
      c. Position indicator on quarter-turn valves.
      d. Worm and gear operators one-piece design worm-gears of gear bronze material. Worm hardened alloy steel with thread ground and polished. Traveling nut type
operators, threader steel reach rods with internally threaded bronze or ductile iron nut.

2. Exposed Operator:
   a. Galvanized and painted hand wheels.
   b. Lever operators allowed on quarter-turn valves 8” and smaller.
   c. Cranks on gear type operators.
   d. Chain wheel operator with tiebacks, extension stem, floor stands, and other accessories to permit operation from normal operation level.
   e. Valve handles to take a padlock, and wheels a chain and padlock.

3. Buried Operator:
   a. Buried service operators on valves larger than 2-1/2” shall have a 2” AWWA operating nut. Buried operators on valves 2” and smaller shall have cross handle for operation by forked key. Enclose moving parts of valve and operator in housing to prevent contact with the soil.
   b. Design buried service operators for quarter-turn valves to withstand 450 foot-pounds of input torque at the FULLY OPEN or FULLY CLOSED positions, grease packed and gasketed to withstand a submersion in water to 10 psi.
   c. Buried valves shall have extension stems, bonnets, and valve boxes.

2.3 VALVE AND GATE OPERATORS

A. Stem Covers:
   1. Aluminum pipe; threaded cap on top; bolted aluminum flange on bottom; 1 by 12 inch slots cut at 18 inches on center in front and back of pipe; capable of covering threaded portion of greased stems that project above operators when gates or valves are opened or closed.

B. Stem Cover Flanges, Pipes and Caps:
   1. Etched and anodized to produce chemical finishes in accordance with AA C 22, medium matte finish, and AA A 41 clear anodic coating, or described in AA publication 45, after fabrication

C. Gate Stem Covers: Concentric with stem

D. Position Indicators:
   1. Tail rods on hydraulic cylinders, or dial indicators with clear full-open and closed position indicators, calibrated in number of turns or percentage of opening.

E. Manual or Power Operator Size:
   1. Sized to deliver maximum force required under most severe specified operating condition, including static and dynamic forces, seat and wedge friction, and seating and unseating forces with safety factor of 5, unless otherwise specified.

F. Operator Size: Capable of supporting weight of suspended shafting unless carried by bottom thrust bearings; shaft guides with wall mounting brackets.

G. Provisions for Alternate Operation: Where specified or indicated on the Drawings, position and equip crank- or handwheel-operated geared valve operators or lifts for alternate operation with tripod mounted portable gate operators.

H. Operation: Counterclockwise to open with suitable and adequate stops, capable of resisting at least twice normal operating force to prevent overrun of valve or gate in open or closed position.

I. Open Direction Indicator: Cast arrow and legend indicating direction to rotate operator on handwheel, chain wheel rim, crank, or other prominent place.
J. Buried Operator Housing: Oil and watertight, specifically designed for buried service, factory packed with suitable grease, completely enclosed space between operator housing and valve body so that no moving parts are exposed to soil; provide operators with 2 inch square AWWA operating nut.

K. Worm Gear Operators: Provide gearing on worm gear operators that is self-locking with gear ratio such that torque in excess of 160 foot-pounds will not need to be applied to operate valve at most adverse conditions for which valve is designed.

L. Traveling Nut Operators: Capable of requiring maximum 100 foot-pounds of torque when operating valve under most adverse condition; limit stops on input shaft of manual operators for fully open and closed positions; non-moving vertical axis of operating nut when opening or closing valve.

2.4 HANDWHEEL OPERATORS

A. Manufacturers: One of the following, or equal:
   1. Rodney Hunt Company.
   2. Waterman Industries, Incorporated.

B. Mounting: Floor stand or bench stand. Unless otherwise indicated on the Drawings position operator 36 inches (nominal) above top of walkway surface.

C. Bearings above and below Finished Threaded Bronze Operating Nut: Ball or roller.

D. Wheel Diameter: Minimum 24-inch.

E. Indicator: Counterclockwise opening with arrow, and word OPEN cast on top of handwheel indicating direction for opening.

F. Pull to Operate: Maximum 40 pounds pull at most adverse design condition.

G. Stem Travel Limiting Device: Setscrew locked stop nuts above and below lift nut.

H. Grease Fittings: Suitable for lubrication of bearings.

2.5 HAND-CRANKED GEARED OPERATORS

A. Type: Single removable crank; fully enclosed.

B. Mounting: Floor and Bench Stand. Unless otherwise indicated on the Drawings, position the operator 36-inches (nominal) above the top of the walkway surface.

C. Operating Nut: When scheduled for portable operators.

D. Geared Lifts: 2-speed with minimum ratio of 4 to 1.

E. Teeth on Gears, Spur Pinions, Bevel Gears, and Bevel Pinions: Cut.

F. Lift Nuts: Cast manganese bronze.

H. Bearings above and below Flange on Lift Nuts: Ball or roller; capable of taking thrust developed by opening and closing of gates under maximum operating head; with bronze sleeve bearings and sufficient grease fittings for lubrication of moving parts, including bearings and gears.

I. Crank Rotation Indicator: Cast arrow with word OPEN in prominent, readily visible location indicating correct rotation of crank to open gate.

J. Hand Cranks: 15 inch radius; requiring maximum 25 pounds pull to operate gate at maximum operating head with:
   1. Revolving brass sleeves.
   2. Gears, spur pinions, bevel gears, and bevel pinions with cut teeth.
   3. Cast manganese bronze lift nuts.
   4. Cast iron lift parts with smooth exterior surfaces.

K. Indicator: Dial position type mounted on gear operator; enclosed in cast-iron or aluminum housing with clear plastic cover; marked with fully open, 3/4, 1/2, 1/4, and closed positions.

2.6 FLOOR BOX AND STEM

A. Manufacturers: One of the following, or equal:
   1. Waterman Industries, Inc.
   2. Neenah Foundry; R 7506.
   3. Clow; No. F5690.

B. Floor Boxes: Cast iron with:
   1. Plain type, for support of non-rising type stem.
   2. Complete with stem, operating nut, and stem guide brackets.
   3. Stem Guide: Space such that stem UR ratio does not exceed 200.
   4. Anchor Bolts: Type 304 SST.
   5. Counter type indicator.
   6. Hinged, lockable lid with directional arrow.
   7. 2-inch square AWWA operating nut.
   8. Packing gland providing drip-tight seal around valve shaft.

2.7 FLOOR STAND AND EXTENSION STEM

A. Manufacturers: One of the following, or equal:
   1. Clow; Figure F-5515.
   2. Mueller, Figure A-26426.

B. Floor Stand Assemblies: Heavy-duty cast iron, suitable for mounting specified operator.
   1. Nonrising, indicating type.
   2. Complete with stem, coupling, hand wheel, stem guide brackets, and yoke attachment.
   3. Stem Guide: Space such that stem UR ratio does not exceed 200.
   4. Anchor Bolts: Type 304 SST.

2.8 BENCH STANDS

A. Manufacturers: One of the following, or equal:
   1. Rodney Hunt Company.
   2. Waterman Industries, Incorporated.
B. Bench Stands: Handwheel operators or hand crank, geared operators conforming to hand-cranked geared operator requirements, except capacity to be mounted on haunch, wall bracket, or self-contained gate yoke.

2.9 ACCESSORY EQUIPMENT

A. T-Handled Operating Wrench:
   1. 2 each galvanized operating wrenches, 4 feet long.
   2. Manufacturers and Products:
      b. Clow No.; F-2520.
   3. 2 each galvanized operating keys for cross handled valves.

B. Extension Bonnet for Valve Operator: Complete with stem and accessories for valve and operator.
   1. Manufacturers and Products:
      a. Metallic Valves:
         1). Pratt.
         2). Allis-Chalmers.

C. Chain Wheel and Guide:
   1. Install chain wheel and guide assemblies or chain lever assemblies on manually operated valves over 6’ 9” above finished floor. Use appropriate “L” type tie-back anchors where chains hang in normally traveled areas. Hand wheel direct-mount type.
   2. Complete with chain.
   3. Galvanized or cadmium-plated.
   4. Manufacturers and Products:
      a. Clow Corp.; Figure F-5680.
      b. Walworth Co.; Figure 804.
      c. DeZurik Corp.; Series W or LWG.

D. Wall Brackets or Haunches: As indicated on the Drawings.

E. Stems: Stainless steel; sized to match output of operator; minimum gate or valve operating stem diameter; maximum 200 slenderness ratio.

F. Stem Couplings: Stainless steel; internally threaded to match stem; lockable to stem by set screw.

G. Stem Guides: Cast iron with silicon bronze bushing; maximum 200 slenderness ratio; capable of being mounted with a wall bracket; adjustable in 2 directions.

H. Wall Brackets: Cast iron, capable of withstanding the output of the operator; adjustable in 2 directions.

I. Stem Stuffing Boxes: Cast iron, with adjustable gland and packing.

J. Fasteners and Anchor Bolts: 316 stainless steel.

K. Geared Valve Operators: Provided with cut gears, either spur or worm; sized to operate valves at most adverse design condition; with maximum 40 pound pull at handwheel or chain wheel rim.
L. Geared Valve Traveling Nut Operators: Acceptable only where specified or indicated on the Drawings.

M. Accessory Equipment for Valves and Gates Requiring Remote Operators: Operating stems, stem couplings, stem guides, wall brackets, and stem stuffing boxes.

PART 3 - EXECUTION

3.1 SHIPPING, STORAGE, HANDLING, AND PROTECTION

A. As specified in Section 01 60 00, PRODUCT REQUIREMENTS.

3.2 INSTALLATION

A. Install floor boxes in concrete floor with lid flush with floor.

B. After installation of gate and stem covers, mark stem covers at point where top of stems are at full-open position and at closed position.

C. Attach floor stand to structure with anchor bolts.

D. Install stem stuffing boxes where operating stems pass through intermediate concrete floor slabs.

3.3 SCHEDULES

A. Geared Operators: Provide geared operators for following valves:
   1. Butterfly valves larger than 6 inches, nominal size, on liquid service.
   2. Butterfly valves larger than 10 inches, nominal size, on gas and air service.
   3. Plug valves 6 inches, nominal size, and larger.

B. Handwheel operators: Provide handwheel operators for valves mounted at 6 feet or less above floors.

C. Chain Wheel Operators; Provide chain wheel operators for valves mounted more than 6 feet to centerline above floors.

END OF SECTION
DIVISION 44

POLLUTION CONTROL EQUIPMENT
SECTION 44 23 23 – VORTEX GRIT REMOVAL EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. This section includes the Work necessary to completely furnish and install the vortex grit removal equipment including all related equipment, material, and appurtenances as shown on the drawings and specified herein.

B. Related sections:
   1. Section 01 33 00 – Submittal Procedures
   2. Section 01 60 00 – Product Requirements
   3. Section 01 78 23 – Operation and Maintenance Data
   4. Section 01 79 00 – Demonstration and Training
   5. Section 05 50 00 – Metal Fabrications
   6. Section 09 90 00 – Painting and Protective Coatings
   7. Division 26 – Electrical

1.2 COSTS OF PRE-NEGOTIATED ITEMS

A. Owner has entered into a pre-negotiated cost agreement with the specified manufacturer for some items in this section of the specification. Refer to Attachment “A” BID FORM for more details. The pre-negotiated cost agreement and proposal from the specified manufacturer is provided as an attachment to this specification section. The Contractor shall carefully review the pre-negotiated proposal and scope of supply to determine those items required by the Contract Documents which are not part of the proposal or specified manufacturer’s scope of supply. In addition to the pre-negotiated costs indicated in Attachment “A” BID FORM, the Contractor shall include in the Lump Sum Bid Price the costs for the following:
   1. All items not specifically itemized in the manufacturer’s scope of supply provided as part of the pre-negotiated proposal but required by the Contract Documents and/or necessary to provide a complete and operational system.
   2. All items specifically itemized in the manufacturer’s scope of supply provided as part of the pre-negotiated proposal which are designated to be provided by others, provided by the customer, provided by the Owner, or any similar designation.
   3. All labor, materials, and all other associated costs not included in the pre-negotiated proposal but required by the Contract Documents and required to provide a complete and operational system.

1.3 GENERAL

A. Equipment Numbers: 10MIX301

B. Like items of equipment provided hereinafter shall be the end products of one manufacturer to achieve standardization of appearance, operation, maintenance, spare parts, and manufacturer’s services.

C. Unit Responsibility: The Work requires that the vortex grit removal equipment, instruments, and components complete with all accessories and appurtenances be the end product of one responsible system manufacturer or responsible system supplier. Unless otherwise indicated, the Contractor shall obtain each system from the responsible supplier of the equipment. The supplier shall furnish all components and accessories of the system to enhance compatibility, ease of operation and maintenance, and as necessary to place the equipment in operation in conformance with the specified performance, features, and functions without altering or modifying the Contractor’s responsibilities under the Contract Documents. The Contractor is responsible to
the Owner for providing the equipment systems as specified herein and in the pre-negotiated agreement which is provided as an attachment to this specification section.

D. General Requirements: See Division 01, GENERAL REQUIREMENTS, which contains information and requirements that apply to the work specified herein and are mandatory for this project.

1.4 SUBMITTALS

A. General: Administrative, shop drawings, samples, quality control, and contract closeout submittals shall conform to the requirements of Section 01 33 00, SUBMITTAL PROCEDURES.

B. In addition to the requirements of Section 01 33 00, SUBMITTAL PROCEDURES, submit the following additional specific information:

1. Shop Drawings:
   a. Make, model, weight, and horsepower of each component.
   b. Manufacturer's catalog information, descriptive literature, specifications, and identification of materials of construction.
   c. Detailed mechanical, and electrical drawings showing the equipment fabrications and interface with other items. Include dimensions, size, and details of anchorage and of connections to other work, and weights of associated equipment.
   d. Test reports demonstrating required performance at existing installations.
   e. External utility requirements (quantity and connection details) such as air, water, power, drain etc., for each component.
   f. Motor nameplate data, motor manufacturer, and any motor modifications.
   g. Wiring diagrams for motors, including terminals and numbers.
   h. Suggested spare parts list to maintain the equipment in service for a period of 1 year and 5 years. Include a list of special tools required for checking, testing, parts replacement, and maintenance with current price information.
   i. List of special tools, materials, and supplies furnished with equipment for use prior to and during startup and for future maintenance.
   j. Instrumentation and Control Submittals: In conformance with Division 26, ELECTRICAL.

2. Quality Control Submittals:
   a. Manufacturer's Certificate of Compliance: Commercial products, including painting/coating systems.
   b. Special shipping, storage and protection, and handling instructions.
   c. Test procedures.
   d. Test results, reports, and certifications.
   e. Manufacturer's Certificate of Proper Installation.
   f. Operation and maintenance manual.
   g. In addition, Quality Control Submittals shall conform to the requirements of Section 01 60 00, PRODUCT REQUIREMENTS.


1.5 QUALITY CONTROL

A. The materials covered under these specifications are intended to be standard equipment of proven reliability and as manufactured by a reputable manufacturer having experience in the production of screening equipment. The equipment furnished shall be designed and constructed in accordance with the best practices and methods and shall operate satisfactorily when installed as shown on the Contract Drawings and operated per the manufacturer's recommendations.

B. Fabrication shall be done in compliance with all applicable ASTM standards or equivalent international standards.
C. Balancing: Rotating elements of equipment, except small, commercially packaged equipment, shall be statically and dynamically balanced at the factory prior to final assembly. The Contractor shall furnish certified copies of all test results.

1.6 OPERATION AND MAINTENANCE DATA

A. O&M Manuals: Content, format, and schedule for providing as specified in Section 01 78 23, OPERATION AND MAINTENANCE DATA.

B. Maintenance Summary Forms: As specified in Section 01 78 23, OPERATION AND MAINTENANCE DATA.

1.7 WARRANTY

A. Provide warranty for a period of 12 months after the final acceptance of the equipment by the Owner and Engineer. The warranty shall stipulate that the equipment furnished is suitable for the purpose intended and free from defects of material and workmanship for the duration of the warranty. In the event the equipment fails to perform as specified, the Manufacturer will promptly repair or replace the defective equipment without additional cost to the Owner.

B. Spare parts identified within this specification shall not be used to address warranty repairs.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Where a manufacturer's standard equipment name and/or model number is listed, the equipment system shall be provided and modified as required to conform to the performance, functions, features, and materials of construction as specified herein.

B. Materials, equipment, and accessories specified in this section shall be products of:
   1. Smith and Loveless

2.2 GENERAL REQUIREMENTS

A. Noise Level: When in operation, no piece of equipment shall exceed the OSHA noise level requirements for a 1 hour exposure, 105 dBA.

B. Service Factors: Service factors shall be applied in the selection and design of components where so indicated in individual sections. When not indicated there, minimum service factors shall be 1.25, except for gears and gear drives as specified herein.

C. Safety Devices: The completed work shall include all necessary permanent safety devices, such as machinery guards, emergency stops, and other federal, state, and local health and safety regulations.

D. Flanges and Pipe Threads: Comply with ANSI B 16.1, Class 125; or B 16.5, Class 150, unless otherwise indicated. Threaded flanges and fittings shall have standard taper pipe threads complying with ANSI/ASME B 1.20.1.

E. Bearings:
   1. Conform to the standards of the Anti-Friction Bearing Manufacturers Association, Inc. (AFBMA).
   2. Except where otherwise indicated, bearings of process equipment shall have a minimum L-10 life expectancy of 100,000 hours.
F. Gears and Gear Drives:
   1. Except as otherwise indicated, gears shall be of the helical or spiral-bevel type, designed and manufactured in accordance with AGMA Standards, with a minimum service factor of 1.7, a minimum L-10 bearing life of 60,000 hours, and a minimum efficiency of 94 percent.
   2. Gear speed reducers or increasers shall be of the enclosed type, oil- or grease-lubricated and fully sealed, with a breather to allow air to escape but keep dust and dirt out. The casing shall be of cast iron or heavy-duty steel construction with lifting lugs and an inspection cover for each gear train. An oil level sight glass and an oil flow indicator shall be provided and installed for easy reading.
   3. Gears and gear drives as part of an equipment assembly shall be shipped fully assembled for field installation.
   4. Material selections shall comply with AGMA values and the manufacturer's recommendations. Input and output shafts shall be properly designed for the service and load requirements. Gears shall be computer-matched for minimum tolerance variation. The output shall have two positive seals to prevent oil leakage.
   5. Oil level and drain location shall be readily accessible. Oil coolers or heat exchangers with all required appurtenances shall be included where indicated.
   6. Where gear drive input to output shafts connect to couplings or sprockets, the gear drive manufacturer shall supply matching key.

G. Anchor bolts shall be specified in Section 05 50 00, METAL FABRICATIONS. Number and size as recommended by manufacturer.

H. Stainless Steel: Stainless steel components shall be 304 stainless steel, or higher, as specified.

I. Nameplates: Equipment nameplates of stainless steel shall be engraved or stamped and fastened to the equipment in accessible locations with stainless steel screws or drive pins. Nameplates shall contain the manufacturer's name, model, serial number, size, characteristics, and appropriate data describing the machine performance ratings.

2.3 SUPPLEMENTS

A. See supplements to this section for additional equipment product, component, or accessory information.

2.4 SERVICE CONDITIONS

A. The grit removal equipment will be used to remove grit from screened wastewater. Grit pumps will transfer grit from the bottom of the grit basin to the grit concentrator/classifier. The classifier will discharge grit into a chute/dumpster for disposal and return overflow to the main process flow.

B. Total Wastewater Flow per Unit:
   1. Design Average Daily Flow: 12 MGD
   2. Design Peak Flow: 30 MGD

C. All grit removal equipment, devices, and accessories shall be suitable for installation and operation outside, unprotected from exposure to the atmosphere. The equipment shall be designed for ambient temperatures ranging from –10°F to 120°F.

D. Grit Characteristics
   1. Type: Typical municipal wastewater grit characteristics and quantities for average daily flow and “first flush” conditions.
2.5 SYSTEM PERFORMANCE AND FUNCTIONAL REQUIREMENTS

A. The grit chamber shall be capable of treating 30 MGD of raw, screened wastewater.

B. The new Vortex Grit Removal System shall be comprised of the following components:
   1. One (1) Mechanical Vortex Grit Removal System

C. Grit Collection Mechanism
   1. Consisting of a vortex type, nonaerated, grit removal mechanism; complete with drive unit, mechanical gearhead, drive tube, and items necessary for complete grit removal assembly.
   2. Capable of removing grit from raw wastewater and suitable for installation in a concrete basin as shown on drawings.
   3. Mechanism shall have no moving parts below the water surface which require lubrication, or which will be subject to wear or blockage.
   4. Drives, bearings, and support equipment for grit mechanism shall be supported or readily accessible from a concrete walkway above the water surface as shown on drawings.

D. Grit Propeller Mechanism
   1. Designed to promote the removal of grit and assist in sweeping grit to the center chamber floor and into the lower grit hopper.
   2. Grit moving across the bottom of the grit chamber shall be hydraulically scoured as the propeller blades pass over the moving grit and cause hydraulic currents to maintain organics in suspension.

E. Equipment using air to supplement or induce a vortex shall not be accepted.

F. Performance Requirements
   1. Remove 95% of all grit particles with specific gravity of 2.65 or greater that are greater than or equal to 50 mesh at a hydraulic capacity of 30 MGD.
   2. Remove 85% of all grit particles with specific gravity of 2.65 or greater that are greater than or equal to 70 mesh at a hydraulic capacity of 30 MGD.
   3. Remove 65% of all grit particles with specific gravity of 2.65 or greater that are greater than or equal to 100 mesh at a hydraulic capacity of 30 MGD.
   4. Grit output is to be less than 5% organic solids at conditions equal to or less than a hydraulic peak flow of 30 MGD.
   5. No more than 18 inches of head loss.

2.6 EQUIPMENT AND/OR MATERIALS

A. General
   1. Welding: All welded joints which will be fully or partially submerged shall be sealed watertight by continuous welds.
   2. Edge Grinding: Sharp projects of cut or sheared edges of ferrous metals which will be submerged in operation shall be ground to a radius by multiple passes of a power grinder as required to ensure satisfactory paint adherence.
   3. Stainless Steel: All welds in stainless steel subassemblies shall be electrochemically cleaned or acid passivated after welding for corrosion resistance and to provide a superior finish. This shall be done by electrochemically removing heat tint and discoloration with a device designed for that purpose or by full dipping of weldments; or by using an acid passivation paste in the weld and heat affected areas and spray on acid solutions elsewhere. After passivation, the weldments shall be thoroughly rinsed with clean water and allowed to air dry. No heat tint or carbon steel contamination shall be evident after this process. If there is contamination evident, the contaminated areas will be cleaned by the above method and rechecked after rinsing and drying. Sandblasting, bead blasting, or grit
blasting of stainless steel surfaces shall not be allowed in lieu of the above procedures. The motor and reducer will be provided with the manufacturer’s standard finish.

4. **Surface Preparation:** All welds shall be thoroughly cleaned and ground smooth in preparation for painting. All ferrous metal surfaces, except motors, speed reducers, and stainless steel, shall be cleaned in accordance with paint manufacturer recommendations before shop primer is applied.

5. **Bolts and Anchor Bolts:** All assembly and anchor bolts, nuts, and washers shall be 316 stainless steel. An anti-seize thread compound shall be applied to all field installed nuts and bolts.

**B. Grit chamber**
1. All wetted components to be 316 stainless steel.
2. The flow in the chamber shall travel a full 360° rotation through the inlet and outlet clockwise, providing maximum travel for effective grit removal.

**C. Grit Removal Mechanism**
1. Axial flow pitch propeller driven by drive tube powered through a gear motor.
2. **Bearing Life**
   a. All bearings of drive unit: L-10 bearing life of 100,000 hours
   b. Turntable bearing supporting propeller assembly: L-10 bearing life of 20 years
3. **Pinion and Bull Gear Service Factor:** 5 or greater

**D. Gear Box:** Sealed and furnish air bell around bottom opening of drive tube to prevent water from entering gearbox.

**E. Grit Fluidizer**
1. The Grit Collection System shall be provided with means of fluidizing the grit prior to extracting the grit from the lower storage hopper. The system shall be equipped with Grit Fluidizer vanes. The Grit Fluidizer vanes shall be located within 6” of the elevation of the pump suction inlet. The Grit Fluidizer vanes shall be connected to the propeller drive tube in a helical fashion.
2. The Grit Fluidizer vanes shall be fabricated of the same material as the drive tube. The Grit Fluidizer vanes shall be bolted to the drive tube to facilitate easy removal of the drive tube.
3. The Grit Fluidizer system shall eliminate the need for additional water lines to the chamber.

**F. Grit Storage Hopper**
1. The grit hopper dimensions shall be as indicated on the Drawings. This is to allow for adequate volume for grit pile expansion if backwashing is performed plus allow adequate storage to prevent excessive numbers of grit removal cycles and grit handling equipment wear. As an integral part of the equipment installation, the Manufacturer shall supply a floor plate to cover the storage hopper if required. The plate shall consist of two (2) sections with lifting slots to allow access to the storage area. Attaching this plate as part of the rotating assembly will not be allowed.

2.7 **ELECTRICAL COMPONENTS AND ACCESSORIES**

**A. General:**
1. Conform with Division 26, ELECTRICAL.
2. Provide all necessary electrical components and wiring for a complete, functional system.
3. Where indicated, motor starters shall be provided in a separate motor control center specified in Division 26, ELECTRICAL. Provide all necessary control functions to properly interface with this motor starter.

**B. Labeling:** All electrical materials, devices, appliances, and equipment used shall be indicated as acceptable by established standards. Indication shall be by a valid label affixed to the item.
C. Wiring: The Drawings and Specifications indicate the anticipated wiring for the equipment provided under this section. If additional wiring is required, or if required wiring does not match what is indicated, the Contractor shall make the necessary modifications to the electrical wiring and documentation as part of the lump sum price. Wiring shall meet the requirements of Division 26, ELECTRICAL, and NFPA 70. Insulation shall be rated 600 volts, minimum. Low-voltage (24V) signals shall be run in twisted, shielded pair cable.

D. Electrical Raceways: Electrical wiring shall be installed in conduit meeting the requirements of Division 26, ELECTRICAL. Raceways shall be installed in accordance with Division 26, ELECTRICAL, and NFPA 70.

E. Motors:
1. Provide squirrel-cage ac induction motors meeting the requirements of Division 26, ELECTRICAL, and as specified herein.
2. For additional specific requirements on motors, refer to the Motor Data Sheets at the end of the Section.

2.8 INSTRUMENTATION AND CONTROLS

A. All instrumentation and controls shall be provided in accordance with the requirements of Division 40.

2.9 TOOLS AND SPARE PARTS

A. Spare parts
1. All equipment shall be furnished with the specified manufacturers spare parts, if required, as indicated in the individual equipment sections.
2. Spare parts, if required, shall be tagged by project equipment number and identified as to part number, equipment manufacturer, and subassembly component (if appropriate). Spare parts subject to deterioration such as ferrous metal items and electrical components shall be properly protected by lubricants or desiccants and encapsulated in hermetically sealed plastic wrapping. Spare parts with individual weights less than 50 pounds and dimensions less than 2 feet wide, or 18 inches high, or 3 feet in length shall be stored in a wooden box with hinged wooden cover and locking clasp. Hinges shall be strap type. The box shall be painted and identified with stenciled lettering stating the name of the equipment, equipment numbers, and the words “spare parts.” A neatly typed inventory of spare parts shall be taped to the underside of the cover
3. Supply the following spare parts, if required, at a minimum:
   a. Drive Pinion Gear
   b. Nylock Capscrew
   c. Motor Bearings

2.10 FABRICATION

A. Shop Assembly: The system shall be factory assembled and tested.

B. Shop/Factory Finishing: Shop prime coatings shall conform to the requirements of Section 09 90 00, PAINTING AND PROTECTIVE COATINGS.

PART 3 - EXECUTION

3.1 GENERAL

A. Coordination shall include space and structural requirements, clearances, utility connections, signals, outputs, and features required by the manufacturer including safety interlocks.
3.2 ASSEMBLY AND PREPARATION FOR SHIPMENT

A. Each drive unit, including motor, shall be completely factory assembled, aligned, and securely crated for shipment. Accessory equipment which cannot be shipped assembled to the unit, such as shafts, baseplates, impellers, spare parts, and anchorage materials, shall be separately crated, clearly marked as to the contents, and shipped on the same shipment as the drives.

B. For shipment, exposed surfaces subject to rust, such as mounting flange faces, etc., shall be covered with a rust-preventive compound such as Kendall No. 5, or equal.

3.3 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. Comply with Section 01 60 00, PRODUCT REQUIREMENTS.

B. Delivery of Materials: Products shall be delivered in original, unbroken packages, containers, or bundles bearing the name of the manufacturer.

C. Storage: Products shall be carefully stored in a manner that will prevent damage and in an area that is protected from the elements.

D. Protection of Equipment: Equipment shall be boxed, crated, or otherwise protected from damage and moisture during shipment, handling, and storage. Equipment shall be protected from exposure to corrosive fumes and shall be kept thoroughly dry at all times. Pumps, motors, drives, electrical equipment, and other equipment with anti-friction or sleeve bearings shall be stored in weathertight and heated storage facilities prior to installation. For extended storage periods, plastic equipment wrappers shall not be used to prevent accumulation of condensate in gears and bearings.

3.4 FIELD QUALITY CONTROL

A. Functional Testing: Prior to startup, all equipment described herein shall be inspected for proper alignment, quite operation, proper connection, and satisfactory performance by means of a functional test. Provide certification of test results. Tests and certification shall be as specified in Section 01 79 00, DEMONSTRATION AND TRAINING.

3.5 INSTALLATION

A. As shown on the Drawings. All anchors, bolts, and accessories shall be 316 stainless steel. The manufacturer shall provide templates for anchor bolt locations.

B. Lubricants: Include oil and grease for initial operation.

3.6 START-UP, TRAINING AND MANUFACTURER’S SERVICES

A. A manufacturer’s representative for the equipment specified herein shall be present at the job site for the minimum person-days listed for the services hereunder, travel time excluded:
   1. Installation, Startup, and Testing Services:
      a. 1 person-day for installation assistance, inspection, and Certificate of Proper Installation.
      b. 1 person-day for functional and performance testing.
      c. Provide Qualifications of Manufacturer’s Representative.
   2. Training Services:
      a. 1 person-day of prestart classroom or jobsite training of Owner’s personnel.
      b. Training of Owner’s personnel shall be at such times and at such locations as required and approved by the Owner.
B. See Section 01 79 00, DEMONSTRATION & TRAINING of Division 01, GENERAL REQUIREMENTS.

3.7 MANUFACTURER'S CERTIFICATE(S)

A. Provide Manufacturer's certificate of installation and commissioning following functional testing and startup.

B. Provide Manufacturer's certificate(s) in accordance with Section 01 79 00, DEMONSTRATION & TRAINING, of Division 01, GENERAL REQUIREMENTS.

3.8 SUPPLEMENTS

A. The supplements listed below and following “END OF SECTION” are part of this Specification:

1. 44 23 23.1 DS-Grit Chamber Drive Motor

END OF SECTION
## Section 44 23 23.1: Grit Chamber Drive Motor Data Sheet

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<tr>
<th>PROJECT:</th>
<th>Western Area WWTP Phase 1 Expansion</th>
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<tr>
<td>OWNER:</td>
<td>City of Huntsville</td>
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<tr>
<td>EQUIPMENT NAME(S):</td>
<td>Grit Chamber No. 3</td>
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<tr>
<td>EQUIPMENT TAG NUMBER(S):</td>
<td>10MIX301</td>
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<td>CONTROL PANEL(S):</td>
<td>See on Drawings</td>
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### MOTOR DATA

<table>
<thead>
<tr>
<th>Type:</th>
<th>Squirrel-cage induction meeting requirements of NEMA MG1.</th>
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<tbody>
<tr>
<td>Manufacturer:</td>
<td>For multiple units of the same type of equipment, furnish motors and accessories of a single manufacturer.</td>
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<tr>
<td>Hazardous Location:</td>
<td>Mark motors for hazardous (classified) locations that conform to UL 674 and have an applied UL listing marking.</td>
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<tr>
<td>Motor Horsepower:</td>
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<tr>
<td>Voltage:</td>
<td>460</td>
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<tr>
<td>Phase:</td>
<td>3</td>
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<tr>
<td>Frequency:</td>
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<td>Synchronous Speed:</td>
<td>1760 rpm</td>
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<td>Enclosure Type:</td>
<td>TEFC</td>
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<tr>
<td>Material:</td>
<td>Cast Iron; A48 Class 35B</td>
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<tr>
<td>Mounting Type:</td>
<td>Vertical</td>
</tr>
<tr>
<td>Load Class:</td>
<td>Constant Torque</td>
</tr>
<tr>
<td>Multispeed, Two Speed:</td>
<td></td>
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<tr>
<td>Adjustable Speed Drive:</td>
<td>Provide Inverter Duty Rated Motors.</td>
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<tr>
<td>Winding:</td>
<td>One, Two, thermal protection embedded in windings.</td>
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<tr>
<td>Service Factor:</td>
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</table>

Motor nameplate horsepower shall not be exceeded at any operational point.

**Additional Motor Requirements:** See Section 26 05 15, ELECTRIC MOTORS

Provide: Space Heater

Oversize main terminal (conduit) box for motors

Moisture Detection Switches

### SPECIAL FEATURES / NOTES
SECTION 44 42 23 – SUCTION PIPE TYPE CLARIFIER MECHANISM

PART 1 - GENERAL

1.1 SUMMARY

A. This section includes the Work necessary to completely furnish and install the suction pipe type clarifier mechanism including all related equipment, material, and appurtenances as shown on the drawings and specified herein.

B. Related Sections:
   1. Section 01 33 00 – Submittal Procedures.
   2. Section 01 60 00 – Product Requirements.
   3. Section 01 78 23 – Operation and Maintenance Data.
   4. Section 01 79 00 – Demonstration and Training.
   5. Division 05 – Metals.
   6. Division 26 – Electrical.

1.2 OWNER FURNISHED MATERIALS

A. Owner has pre-purchased portions of the clarifier system to be provided to the Contractor for installation. The detailed scope of supply for Owner furnished items is provided in the designated volume of the project documents. The Contractor shall carefully review the scope of supply to determine those items required by the Contract Documents which are not part of the proposal or specified manufacturer’s scope of supply. Costs for installation of Owner furnished materials shall be included in the relevant Lump Sum Bid Price items of the bid form and shall include costs for the following:
   1. All items not specifically itemized in the Owner’s scope of supply but required by the Contract Documents and/or necessary to provide a complete and operational system.
   2. All items specifically itemized in the Owner’s scope of supply which are designated to be provided by others, provided by the customer, or any similar designation.
   3. All labor, materials, and all other associated costs not included in the Scope of Supply but required by the Contract Documents and required to provide a complete and operational system.

1.3 GENERAL

A. Equipment Numbers: See Supplemental Data Sheet(s) at end of section.

B. Like items of equipment provided hereinafter shall be the end products of one manufacturer to achieve standardization of appearance, operation, maintenance, spare parts and manufacturer’s services.

C. Unit Responsibility: The Work requires that the clarifier mechanisms, walkways, scum beaches, weirs, baffles, and components, complete with all accessories and appurtenances be the end product of one responsible system manufacturer or responsible system supplier. Unless otherwise indicated, the Contractor shall obtain each system from the responsible supplier of the equipment, which supplier shall furnish all components and accessories of the system to enhance compatibility, ease of operation and maintenance, and as necessary to place the equipment in operation in conformance with the specified performance, features, and functions without altering or modifying the Contractor's responsibilities under the Contract Documents. The Contractor is responsible to the Owner for providing the equipment systems as specified herein.
D. General Requirements: See Division 01, GENERAL REQUIREMENTS, which contains information and requirements that apply to the work specified herein and are mandatory for this project.

1.4 REFERENCES

A. The following is a list of standards which may be referenced in this Section:


E. American National Standards Institute/American Gear Manufacturers Association (ANSI/AGMA):
   7. 6001-D97, Design and Selection of Components for Enclosed Gear Drives.
   10. 6034-B92, Practice for Enclosed Cylindrical Wormgear Speed Reducers and Gearmotors.
   11. 9005-D94, Industrial Gear Lubrication.


G. American Welding Society (AWS):
   3. QC 1, Standard for AWS Certification of Welding Inspectors.

H. ASTM International (ASTM):
14. A666, Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar.

I. National Electrical Manufacturers Association (NEMA): 250, Enclosures for Electrical Equipment (1,000 Volts Maximum).
   1. NEMA MG-1.

1.5 DEFINITIONS

A. Alarm Torque: 90 percent of design running torque.
B. Cutout Torque: 120 percent of design running torque.
C. Design Running Torque:
   1. Torque used to select size, strength, and type of materials and components for mechanism and drive system.
   2. At which or below will provide continuous 24 hour per day mechanism operation for period of not less than 20 years at design torque condition and rotational speed without damage, permanent deformation or overload.
   3. Equal to 50 percent on overload device scale.
D. Slenderness Ratio: Ratio of unbraced length to least radius of gyration.
E. Submerged Metal: Metal below gear head drive and a plane 18 inches above weir elevation indicated.
F. Ultimate Torque: 200 percent of design running torque and below which no portion of mechanism will be damaged if operated for only a short period of time (a few seconds) and equal to 100 percent on overload device scale.
G. Certified Welding Inspector (CWI): As defined in AWS QC 1.

1.6 SUBMITTALS

A. General: Administrative, shop drawings, samples, quality control and contract close-out submittals shall conform to the requirements of Section 01 33 00, SUBMITTAL PROCEDURES.
B. In addition to the requirements of Section 01 33 00, SUBMITTAL PROCEDURES, submit the following additional specific information:
   1. Shop Drawings:
      a. Equipment Assembly: Make, model, weight, and horsepower of each.
      b. Manufacturer’s Catalog: Product information, descriptive literature, dimensional layouts, specifications, standard and specialized equipment assembly cuts, and identification of materials of construction.
      c. Detailed Drawings:
1). Structural, Mechanical, and Electrical: Show equipment fabrications and interface with other items including dimensions, size, and locations of connections to other work, and weights of associated equipment.

2). Structural and Mechanical: Details of walkway bridge, rotating rake arm trusswork.

   d. Design Details:
      1). Running, Alarm, Cutout, and Ultimate Torque ratings of drive unit assembly.
      2). Ultimate Torque load capabilities of drive unit assembly, torque cage, rotating rake arm trusswork.

   e. Hydraulic calculations and performance verification data.

   f. Certification of Structural Calculations: Letter of certification for structural design of mechanism shall be signed and sealed by a registered professional engineer (Designer) in the state where the Project is located. Copies of detailed structural design calculations shall not be submitted for review. If submitted, calculations will be returned without review.

   g. Structural Loads: Static, dynamic, and torque reaction loads to be transferred into structure at center column and access bridge support locations.

   h. Details of torque sensing and load indication device.

   i. Identification of outside utility requirements for each component such as air, water, and power.

   j. Power and control wiring diagrams, including terminals and numbers.

   k. Functional description of internal and external instrumentation and controls to be supplied including list of parameters monitored, controlled, or alarmed.

   l. Painting/Coating System(s): Include manufacturer’s descriptive technical catalogue literature and specifications.

   m. Motor nameplate data per NEMA MG-1, motor manufacturer and any appurtenances.

   n. Functional and Performance test description and results.

2. Quality Control Submittals:
   a. Designer qualifications:
      1). Designer: Professional engineer registered in the state of the Project.
      2). Must show 10 years of experience with clarifier mechanism design.

   b. Manufacturer’s Certificate of Compliance, in accordance with Division 01, GENERAL REQUIREMENTS.

   c. Special shipping, storage and protection, and handling instructions.

   d. Test procedures.

   e. Test results, reports, and certifications.

   f. Operation and Maintenance Data: As specified in Division 01, GENERAL REQUIREMENTS.

   g. Manufacturer’s Certificate of Proper Installation.


1.7 OPERATION AND MAINTENANCE DATA

A. O&M Manuals: Content, form, and schedule for providing as specified in Section 01 78 23, OPERATION AND MAINTENANCE DATA.

B. Maintenance Summary Forms: As specified in Section 01 78 23, OPERATION AND MAINTENANCE DATA.
1.8  WARRANT

A.  The warranty shall be for a minimum period of 12 months from start-up. The warranty shall stipulate that the equipment furnished is suitable for the purpose intended and free from defects of material and workmanship for the duration of the warranty. In the event the equipment fails to perform as specified, the Manufacturer shall promptly repair or replace the defective equipment without additional cost to the Owner.

B.  Spare parts identified within this specification shall not be used to address warranty repairs.

PART 2 - PRODUCTS

2.1  MANUFACTURERS

A.  Where a manufacturer's standard equipment name and/or model number is listed, the equipment system shall be provided as modified to conform to the performance, functions, features, and materials of construction as specified herein.

B.  Materials, equipment, and accessories specified in this Section shall be products of:

   1.  Ovivo – C3S Suction Tube Clarifier

2.2  SUPPLEMENTS

A.  See supplemental data sheets to this Section for additional equipment system product, component, and accessory information and requirements.

2.3  SERVICE CONDITIONS

A.  All of the equipment specified herein is intended to be standard equipment for use with mixed liquor suspended solids from the activated sludge process.

B.  Provide each mechanism for installation in a circular concrete tank having the dimensions as shown in the drawings and specified herein. Each mechanism shall be designed to:

   1.  Disperse the influent waste liquid into the tank and control short circuiting.
   2.  Collect and remove settled solids from the clear liquid.
   3.  Remove clear liquid equally from the clarifier.
   4.  Transport and thicken settled sludge.
   5.  Prevent dilution of the sludge at the sludge withdrawal points.
   6.  Collect floating scum from the liquid surface and discharge to scum handling system.

2.4  SYSTEM PERFORMANCE AND FUNCTIONAL REQUIREMENTS

A.  Furnish units meeting performance and design requirements as specified and as shown on the Drawings.

B.  Design Requirements:

   1.  Design Running Torque: Drive unit shall be sized such that worm gear (if used), spur gear, and pinion all meet Design Running Torque in accordance with AGMA 2001 and 6034. Design Running Torque shall be selected by Manufacturer for service conditions specified.
   2.  Rotational Speed: Constant speed between 0.03 rpm and 0.04 rpm.
   3.  Capable of withstanding, without failure or permanent deformation of any part, torque load of at least twice Design Running Torque and loads generated while sweeping in clarifier floor bottom grout.
5. Drive Mechanism: Design to allow removal of internal gears, balls, and strip liners without walkway bridge removal.
6. Base design upon all-welded construction except at locations requiring periodic field adjustment and as specifically approved.
7. At Ultimate Torque load, stresses in members shall not exceed 90 percent of material yield strength.
8. Slenderness Ratio: Maximum of 200 for any compression member and maximum of 300 for any tension member.

2.5 CENTER DRIVE UNIT ASSEMBLY

A. The center drive assembly shall consist of an integral motor and primary speed reducer coupled through roller chain and sprockets to a secondary worm/worm gear reducer driving the main gear through a pinion and shall have an integral overload protection system.

B. All gears and bearings shall be oil bath lubricated with the main bearing totally submerged in oil and the teeth of the main spur gear submerged at least 85 per cent in the oil bath. Oil pumps for lubrication or grease lubricated bearings are not considered appropriate for this application and will not be allowed. The oil reservoir for the main bearing and gear shall have a section of minimum depth 5 inches below the main bearing to positively prevent contamination of the main bearing and gears with condensate or other contaminants. Gear and bearing housings must also be fitted with oil level sight glasses and condensate drains. Condensate must be allowed to drain from a low point of the housing.

C. Drive components will be located via a machined, registered fit to preserve the alignment of key drive components under all load conditions. Inspection of the completed drive unit shall be accomplished at the clarifier manufacturer's shop, with reports of all tests and certifications of material hardness being made available for review at the Engineer's request prior to shipment to the job site.

D. Major drive components, main gears and bearings must be designed to allow for separate and individual replacement by plant personnel to facilitate quick and economical repairs.

E. The complete center drive assembly, including the overload protection device, shall be a regularly manufactured in-house product of the clarifier manufacturer. The center drive assembly is a key element in a successful clarifier installation, therefore drive assemblies purchased from third party vendors will not be accepted.

F. The drive motor shall be minimum 3/4 horsepower and shall be totally enclosed, fan cooled, with a 1.15 service factor, and have bearings with a minimum B10 rating of 50,000 hours. Operating electric current will be 230/460 volt, 3 phase, and 60 hertz. Each motor will be NEMA Design B employing Class F insulation designed for an ambient temperature of 40 degree. C.

G. The gearmotor primary speed reducer shall drive a secondary worm gear reducer through a #60 roller chain and steel sprockets enclosed in a galvanized 18 gauge steel guard. Sprockets and chain shall be designed for the connected horsepower of the drive with a minimum service factor of 1.4. Provision shall be made for adjustment of chain tension.

H. The main drive unit shall consist of a worm gear secondary reduction unit, pinion and main spur gear assembly. The secondary reducer shall be a worm/worm gear reducer specifically designed for this application. The worm gear shall be centrifugally cast manganese bronze. The worm shall be hardened alloy steel. A single piece pinion shall be keyed to the worm gear to transmit power from the worm gear to the spur gear. In order to maintain proper alignment between the pinion and the spur gear, the pinion will be supported by bearings both above and below the spur
The bearings shall be fitted into precision machined bearing pilots to positively insure bearing and gear alignment.

I. The main spur gear material shall be cast iron per ASTM A536 grade 100-70-03 or equal. The gear shall have a minimum pitch diameter of 40 inches with a 6.0 inch face width or the equivalent spur gear surface area of 754 square inches. Spur gear surface area is defined as the spur gear pitch diameter multiplied by the spur gear face width multiplied by 3.14.

J. The main gear shall rotate and be supported on a ball bearing assembly provided with four replaceable liner strips fitted into the main gear and turntable base. Liner strips shall be special vacuum degassed carbon corrected alloy steel hardened to a Rockwell hardness of at least 43 to 46 Rc. The turntable base shall be a minimum 1 inch thick to insure adequate structural rigidity to properly support the drive bearing and gear.

K. The main gear and bearing shall be completely enclosed in an ASTM A-48 Class 40A cast iron housing provided with neoprene dust seals. In order to ensure the maximum possible base rigidity the gear housing shall be of full sidewall construction, integral with the base. Fabricated steel housing drives are not acceptable. Prior to assembly, the base shall be thoroughly inspected for seep holes or inclusions and given a hydrostatic test to insure no leaks are in the oil containment area. Shop inspection reports must be made available for review.

L. The drive unit shall be equipped with an electro-mechanical overload control device actuated by thrust from the worm shaft. The pointer shall provide a visual reading of the relative main gear output torque on a 0 to 100 percent graduated scale. The 100 percent reading shall equal the 100 percent drive rating as specified in section 1.03. The control device shall also activate an alarm switch for warning of impending overload, a motor cutout switch for overload protection and a back-up safety motor cutout switch for back up overload protection. In lieu of a back-up safety motor cutout switch a slip clutch assembly will be acceptable upon review by the Engineer. The respective switches in the overload control device shall be factory calibrated and set to the following settings:
   1. Alarm; 40% of scale.
   2. Motor cutout; 85% of scale.
   3. Back-up motor cutout; 100% of scale.

M. All drive control components shall be mounted in a NEMA 4X enclosure of either epoxy coated aluminum construction or stainless steel with a gasket sealed removable cover. The pointer shall be covered with a plexi-glass enclosure and shall be above the walkway surface for visibility from the walkway. Amperage sensing devices are not acceptable for torque overload protection due to their inability to react quickly enough to prevent damage to the drive. Overload devices with exposed linkage connections will not be accepted due to possible corrosion problems. Devices which react to rotational movement of the secondary reduction unit will not be allowed due to possible misalignment of gearing created by the movement of the reduction unit.

N. The center drive unit shall be designed for the continuous torque rating as specified in this section. The continuous torque shall be defined as the minimum torque at which the drive mechanism may operate continuously 24 hours per day, 365 days per year, for 20 years, at the specified sludge collector arm speed. Main gear and pinion calculations shall be based upon ANSI/AGMA 2001-C95 standards for rating the pitting resistance and bending strength of involute spur and helical gear teeth. Calculations shall clearly present the values used for the following design parameters:
   1. Number of pinions
   2. Actual face width
   3. Tooth geometry (I and J factors)
   4. Load distribution factor
   5. Allowable contact stress
   6. Allowable bending stress
7. Pinion pitch diameter  
8. Hardness ratio factor  
9. Elastic coefficient  
10. Life factor  

O. The load distribution factor shall be determined by the empirical method. For parameters which are material dependent, such as allowable contact stress, the calculations shall include a complete description of material and heat treatment used.  

P. Worm gearing shall be designed and rated to equal or exceed the specified continuous torque and life. The basis for rating shall be ANSI/AGMA 6034-B92 standards for durability rating and design of wormgear reducers.  

Q. The continuous torque rating for the drive unit shall be the lowest value determined for the gearing.  

2.6 STATIONARY CENTER INFLUENT COLUMN  

A. A stationary center column shall be provided which shall serve as the influent pipe. One end shall have a 1-1/4 inch support flange for bolting to the foundation with a minimum of eight (8) 1-1/4 inch diameter anchor bolts as shown on the plans. A minimum ¾” flange shall be provided at the top of the column for supporting and securing the center drive assembly.  

B. Two (2) sets of ports shall be included at the upper end. One set of upper ports shall convey the return sludge from the overflow valves to the central discharge pipe. The other set of ports shall diffuse the flow entering the tank and insure low velocity into influent well. Influent velocity shall be reduced by providing a minimum total column port area of at least 135% of the column cross sectional area. Upper and lower ports shall be separated by a neoprene seal with steel backing ring.  

C. Inside the support column there shall be a sludge discharge pipe minimum diameter as specified in supplemental data sheet by 1/4” wall thickness. It shall extend from the bottom of the sludge collection drum to 1’ 0 above the tank bottom of the stationary influent column and shall connect to the sludge discharge pipe cast in the concrete by the contractor. A backing ring and clamp shall be provided to seal the two pipes together. The contractor shall provide a suitable packing or nylon rope to seal the discharge (RAS) pipes at the energy dissipating inlet.  

2.7 ENERGY DISSIPATING INLET  

A. An inner energy dispersion well shall be located within the larger rotating feedwell. See Supplemental data sheet for minimum EDI dimensions. Eight (8) tangential inlet gates shall be provided with a means of adjustment. The dispersion well shall be fabricated out of 3/16 inch plate and shall be provided with a steel bottom plate to within one inch of the center column.  

2.8 FEEDWELL  

A. The feedwell shall be supported by structural members attached to the rotating center cage. The feedwell shall be fabricated from 3/16 inch steel plate with upper and lower reinforcing rim angles and stiffeners as required. A minimum of eight (8) scum ports, 4 inches high x 16 inches long, shall be provided equally spaced around the feedwell periphery to allow scum to exit from the feedwell at water level. Scum ports shall be free to allow scum to escape with an adjustable, angled baffle plate to impart a tangential direction of the flow exiting the scum port. See Supplemental data sheet for minimum feed well dimensions. The feedwell design shall include 6” freeboard.
2.9 ACCESS WALKWAY

A. The clarifier shall be provided with a 36 inch clear, open width walkway extending from the tank wall to the center drive platform. The walkway shall be supported at the center by the drive unit and supported on the opposite end by the tank wall. As a minimum the walkway shall be designed to safely withstand all dead loads plus a live load of 50 pounds per square foot with a maximum deflection of l/360, over the entire span. The walkway shall consist of truss supports, sufficiently braced to resist the specified design loads. The walkway decking shall be 1-1/4 inch aluminum I-Bar grating.

B. A center drive operations platform shall be provided. It shall be a minimum of 9 feet square or 3-feet clear around drive unit, whichever is greater, to provide clearance around the center assembly and drive control for maintenance and service. The drive platform shall be decked with 3/8 inch aluminum checkered floor plate and have sufficient structural steel supports to meet the specified design load conditions.

C. Provide handrails with toe plate around the center drive platform. The handrail shall be 1-1/2 inch diameter aluminum pipe, 2-rail design, with fittings factory assembled to posts. Rails are to be shipped to the job site in stock lengths for cutting and fitting. The toe plate shall be a 4 inch x ⅛ inch plate or a 4” tall aluminum extruded channel. The walkway truss supports may be used in place of handrailing along the walkway if it meets OSHA standards for this application.

2.10 CENTER CAGE AND RAKE ARMS

A. The center cage shall be of steel box truss construction. It shall be provided with connections for the two (2) sludge removal arms and feedwell supports. The top of the cage shall be bolted to the main gear which shall rotate the cage with the attached arms and feedwell. The minimum angle size used for construction of the cage and rake arms shall be 2 inch x 2 inch x 1/4 inch members.

B. The two (2) sludge removal arms shall be of steel truss construction, with ¼” steel raking blades and adjustable 20 gauge, 304 stainless steel squeegees. The rake blades shall be properly spaced to insure complete raking of the basin floor twice per revolution. At the sludge withdrawal pipe locations an additional blade shall be provided opposite the raking blade to direct sludge to the pipe in a “V” shape.

C. The cage and rake arms shall be designed such that calculated stresses do not exceed the AISC allowable stress at the 200% of the drive rated AGMA continuous torque.

D. Each rake arm shall be provided with withdrawal pipes of PVC ASTM 3034 piping. Change of direction shall be through long radius elbows. The PVC pipes shall be arranged for easy assembly with minimum trimming. The maximum total sludge return flow specified shall be based on utilization of withdrawal pipes of the diameter specified in Supplemental data sheet. The withdrawal pipes shall be attached to the rake arms at their lower end by means of 304 stainless steel clamps and shall pass along the arms and vertically upward to the rotating sludge discharge well.

2.11 ROTATING SLUDGE COLLECTION BOX:

A. Inside the feedwell, and supported from the rotating cage, shall be provided a sludge collection box. It shall contain a sludge control valve for each sludge draw off pipe. A neoprene seal shall be provided between the rotating sludge collection box and center column. An adjusting handle for each mechanism shall be provided with sufficient chain and be attached to the platform handrail. Each valve shall control the sludge by a rotating action, increasing or decreasing the valve opening.
2.12 SCUM COLLECTION

A. Surface scum skimming equipment shall be furnished with the clarifier mechanism. It shall be arranged to have the surface scum swept along an angled skimmer blade to the skimmer assembly, attached at the end of the blade, for discharge to the scum box as shown on the plans. The surface of the clarifier shall be swept once per revolution.

B. The skimmer blade shall be tangential to the rotating feedwell and be supported by vertical supports from the rake arm. The skimmer assembly shall be a pivoting aluminum skimmer device equipped with manual out-of-service lock out. The skimmer shall have replaceable neoprene rubber wipers on all three sides to form a pocket to trap the scum and discharge the scum into the scum box.

C. The scum box shall be 10 feet wide, shall be supported from the tank wall and connected to a six (6) inch scum line, all as shown on the contract drawings.

D. The clarifier equipment manufacturer shall furnish a flush valve assembly for automatic flushing of the scum trough and scum pipe. The flush valve assembly shall be adjustable to allow 0 to 20 gallons of clarified effluent to enter the scum trough as the skimmer assembly passes over the scum trough. The assembly shall consist of a stainless-steel lever, UHMW seal plate and neoprene diaphragm mounted to the scum box. The diaphragm shall be opened and closed by an easily adjustable, submerged actuation arm mounted to the rotating skimmer blade. The flush volume adjustment mechanism shall be above the water level and shall include at least three settings.

2.13 WEIRS AND BAFFLES

A. Minimum ¼ inch thick aluminum v-notch weirs. 3-inch notch at 6-inches on center. 9 in overall plate height.

B. Aluminum scum baffles shall be provided to prevent scum from flowing over the weirs and entering the effluent trough.

2.14 PAINTING AND SURFACE PREPARATION

A. Submerged fabricated steel will receive surface preparation of SSPC-SP-10 and will be prime coated with one (1) coat of Tnemec Series 66HS to 4-6 mils.

B. Non-submerged fabricated steel will receive surface preparation of SSPC-SP-10 and will be prime coated with one (1) coat of Tnemec Series 66HS to 4-6 mils.

C. The drive unit will receive a surface preparation of SSPC-SP-06 and will be finish coated by manufacturer with two (2) coats of Tnemec 66HS and one (1) coat of Tnemec Endura-shield series 73. Gear motors shall be furnished with manufacturer's standard enamel.

D. Gear motors shall be furnished with manufacturer's standard enamel.

2.15 ELECTRICAL COMPONENTS AND ACCESSORIES

A. General:
1. Conform to Division 26, ELECTRICAL.
2. Provide all necessary electrical components and wiring for a complete, functional system.
3. Motor starter for the clarifier is provided in a separate motor control center specified in Division 26, ELECTRICAL. Provide all necessary control functions to properly interface
with this motor starter, including clarifier torque switches, motor space heater, and motor thermal protection switch.

B. Wiring: The Drawings and Specifications indicate the anticipated wiring for the equipment provided under this section. If additional wiring is required, or if required wiring does not match what is indicated, the Contractor shall make the necessary modifications to the electrical wiring and documentation as part of the lump sum price. Wiring shall meet the requirements of Division 26, ELECTRICAL, and NFPA 70. Insulation shall be rated 600 volts, minimum. Low-voltage (24V) signals shall be run in twisted, shielded pair cable.

C. Electrical Raceways: Electrical wiring shall be installed in conduit meeting the requirements of Division 26, ELECTRICAL. Raceways shall be installed in accordance with Division 26, ELECTRICAL, and NFPA 70.

2.16 INSTRUMENTATION AND CONTROLS

A. All instrumentation and control components shall be provided in accordance with the requirements of Division 40.

B. General: The Drawings and these Specifications depict the minimum functional requirements of the control system to be provided. Provide all items not specifically called out which are required to implement the functions described herein. The supplier shall provide all instrumentation and controls necessary to provide a safe and operable system. The specific control system proposed shall be subject to the approval of the Engineer.

C. Instrumentation: Provide and install an electromechanical torque sensing-device that is actuated by thrust from the worm gear. The device shall provide indication of torque sensed and shall provide two independently adjustable SPDT torque alarm contacts (HIGH and HIGH-HIGH). The device shall be mounted in a NEMA 4X enclosure with an integral conduit box and terminals. Contacts shall be rated for a minimum of 5A at 120V ac.

2.17 DISSIMILAR METALS

A. Isolate dissimilar metals or connectors to prevent direct contact and electrical conductivity. Use 1/8-inch thick continuous neoprene gasket to insulate aluminum gratings, checker plate and handrail post bases from access walkway support bridge and other components. Use insulating washers and Teflon sleeves at bolted connections.

2.18 ACCESSORIES

A. Lifting Lugs: Provide on equipment assemblies and components weighing over 100 pounds.

B. Anchor Bolts: Provide coated Type 316, stainless steel bolts, sized by equipment manufacturer and at least 1/2 inch in diameter.

C. Equipment Identification Plates: Provide 16-gauge, Type 316 stainless steel, identification plate securely mounted on each separate equipment component and panel in a readily visible location. Plate shall bear 1/4-inch high engraved block type black enamel filled equipment identification number and letters.

2.19 TOOLS AND SPARE PARTS

A. Tools: The work includes furnishing one complete set of special tools recommended by the manufacturer for maintenance and repair of each separate type of equipment; tools shall be
stored in tool boxes, and identified with the equipment number by means of stainless steel or solid plastic name tags attached to the box.

B. Spare Parts:
   1. The intent of this specification is to provide uninterrupted operation for a minimum period of two (2) years. To meet this objective the clarifier manufacturer shall supply any spare parts, excluding lubricants, that are required to meet this time frame. As a minimum provide the following spare parts per mechanism:
      a. One (1) set of oil sight glasses
      b. One (1) set of neoprene skimmer wipers

2.20 FABRICATION

A. General: Fabricate bridge beam or stringer sections in continuous unbroken pieces.

B. Shop Assembly:
   1. Shop fabricate and assemble mechanism components in the largest sections practicable and permitted by transportation carrier regulations.
   2. Properly match-mark units for ease of field erection.
   3. Completely assemble center drive unit in manufacturer’s shop and test to assure proper operation, and calibration of torque controls.
   4. Completely shop assemble and test control panels.
   5. Divide large assemblies into flanged sections. Bolt together with Type 316 stainless steel fasteners and provide continuous field seal welds at all connections.

C. Finishes:
   1. Exposed metal surfaces of motors, gear reducers, and assemblies shall be factory prepared and primed and field finish coated in accordance with Section 09 90 00, PAINTING AND PROTECTIVE COATINGS, System No. 3.
   2. Submerged surfaces shall be factory prepared, primed, and field finished in accordance with Section 09 90 00, PAINTING AND PROTECTIVE COATINGS, System No. 2.
   3. Seal welding shall be provided for submerged welded joints. Skip welds are not acceptable.

PART 3 - EXECUTION

3.1 ASSEMBLY AND PREPARATION FOR SHIPMENT

A. Each drive unit, including motor, shall be completely factory assembled, aligned, and securely crated for shipment. Accessory equipment which cannot be shipped assembled to the unit, such as shafts, baseplates, impellers, spare parts, and anchorage materials, shall be separately crated, clearly marked as to the contents, and shipped on the same shipment as the drives.

B. For shipment, exposed surfaces subject to rust, such as mounting flange faces, etc., shall be covered with a rust-preventive compound such as Kendall No. 5, or equal.

3.2 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. Comply with Section 01 60 00, PRODUCT REQUIREMENTS.

B. Delivery of Materials: Products shall be delivered in original, unbroken packages, containers, or bundles bearing the name of the manufacturer.

C. Storage: Products shall be carefully stored in a manner that will prevent damage and in an area that is protected from the elements.
D. Protection of Equipment: Equipment shall be boxed, crated, or otherwise protected from damage and moisture during shipment, handling, and storage. Equipment shall be protected from exposure to corrosive fumes and shall be kept thoroughly dry at all times. Mechanisms, motors, drives, electrical equipment, and other equipment with anti-friction or sleeve bearings shall be stored in weathertight and heated storage facilities prior to installation. For extended storage periods, plastic equipment wrappers shall not be used to prevent accumulation of condensate in gears and bearings.

3.3 INSTALLATION

A. Installation shall be by the Contractor with coordination from Manufacturer.

B. Anchor Bolts: Provide templates and specify bolts for furnishing by Contractor.

C. Manufacturer shall coordinate with Contractor during all phases of installation to ensure that manufacturer’s representative is present during critical installation operations.

3.4 FIELD QUALITY CONTROL

A. Prior to placement of clarifiers into service, check weir plate settings by filling clarifiers with water to design elevation shown on the Drawings. Readjust as recommended by Engineer.

B. Weirs: Level to within plus or minus 1/16 inch of design elevation.

C. Functional Tests: Conduct on each mechanism. Test for continuous 3-hour period without malfunction, as witnessed by and approved by Owner or Engineer.

D. Performance Test:
   1. Conduct on each completed assembly in accordance with accepted test procedures.
   2. Perform under actual or approved simulated operating conditions.
   3. Perform to confirm mechanical and structural compliance with specified torque requirements.
   4. Load each mechanism to 120 percent of Design Running Torque to demonstrate mechanism’s structural capability to withstand resulting loads with one of the following methods:
   5. Apply loads to mechanism’s rake arms through cables or other means anchored to basin floor or wall. Utilize hydraulic cylinder, springs, or other means that allows machine to rotate for peripheral distance of at least 3 feet under load.
   6. Conduct static torque test on mechanism. Anchor both collector arms, start collector drive, and load drive to 120 percent of Design Running Torque to demonstrate mechanism’s structural capability to withstand resulting loads.

E. Demonstrate mechanism overload devices; verify actual torques at which Alarm and Cutout (shutdown) contacts are actuated.
   1. Correlate with scale indications.
   2. Prepare test report containing results.

3.5 MANUFACTURERS’ SERVICES

A. A manufacturer’s representative for the equipment specified herein shall be present at the job site for the minimum person-days listed for the services hereinunder for each unit provided, travel time excluded:
   1. Installation, Startup, and Testing Services:
a. 1 person-day for installation assistance, inspection, and Certificate of Proper Installation.

b. 1 person-day for functional and performance testing.

c. Provide Qualifications of Manufacturer’s Representative.

2. Training Services:
   a. 1 person-day of prestart classroom or jobsite training of Owner’s personnel.
   b. Training of Owner’s personnel shall be at such times and at such locations as required and approved by the Owner.

   B. See Section 01 79 00, DEMONSTRATION & TRAINING of Division 01, GENERAL REQUIREMENTS.

3.6 MANUFACTURER’S CERTIFICATES

   A. Provide Manufacturer’s certificate(s) in accordance with Section 01 79 00, DEMONSTRATION AND TRAINING.

3.7 SUPPLEMENTS

   A. The supplements listed below and following "END OF SECTION" are part of this Specification.

      1. Section 44 42 23.1 – Final Clarifier Mechanism Data Sheet

END OF SECTION
### Section 44 42 23.1 – FINAL CLARIFIER MECHANISM DATA SHEET

**PROJECT:** Western Area WWTP Phase 1 Expansion  
**OWNER:** City of Huntsville  
**EQUIPMENT NAME(S):** Final Clarifier No. 5  
**EQUIPMENT TAG NUMBER(S):** 40SC501  
**LOCAL CONTROL PANEL(S):** 40LCP501

#### MANUFACTURERS

Ovivo, LLC

#### SERVICE CONDITIONS

<table>
<thead>
<tr>
<th>Liquid Handled:</th>
<th>Mixed Liquor Suspended Solids</th>
<th>The clarifier shall perform as specified at the following flow rates:</th>
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</thead>
<tbody>
<tr>
<td>Influent MLSS</td>
<td>2,000 – 5,000 mg/L</td>
<td>Influent Flow Rate: 1 – 17.5 MGD</td>
</tr>
<tr>
<td>Liquid Temperature:</td>
<td>50 – 85°F</td>
<td>Under Flow Rate: 0.5 – 5 MGD</td>
</tr>
<tr>
<td>Liquid pH</td>
<td>5.5 – 9.0</td>
<td>Under Flow Solids: 3,000 – 10,000 mg/L</td>
</tr>
<tr>
<td>Elevation</td>
<td>See Drawings</td>
<td></td>
</tr>
</tbody>
</table>

#### PERFORMANCE REQUIREMENTS

#### EQUIPMENT DESCRIPTION

Clarifier Diameter: 130’-0”  
SWD: 15’-10”  
Floor Slope: 1:12  
Center Pier Dia.: 42” max.  
Type: Pier Supported, Center Drive  
Scrapper Blades: Suction Pipe  
Min. Sludge Collection Pipe: 6” Dia.  
EDI Diameter: 14’-0”  
EDI Side Depth: 5’-0”  
EDI & Inlet Well Freeboard: 6”  
Scum Baffles: Yes  
Density Current Baffles: No

#### MOTOR DATA

Type: Squirrel-cage induction meeting requirements of NEMA MG1.  
Manufacturer: For multiple units of the same type of equipment, furnish motors and accessories of a single manufacturer.  
Hazardous Location: Furnish motors for hazardous (classified) locations that conform to UL 674 and have an applied UL listing marking.  
Motor Horsepower: 0.75 (min)  
Voltage: 460  
Phase: 3  
Frequency: 60  
Max. Synchronous Speed: 1,800 rpm  
Load Class: Constant Torque  
Service Factor: 1.0  
Variable Speed Drive: See Division 26, ELECTRIC, Provide Inverter Duty Rated Motors.  
Winding: One  
Thermal protection embedded in windings  
Motor nameplate horsepower shall not be exceeded at any operational point.  
Provide: Space Heater  
Oversize main terminal (conduit) box for motors  
Moisture detection switches

#### SPECIAL FEATURES / NOTES


SECTION 44 42 27.20 – SCREENINGS WASHER COMPACTOR

PART 1 - GENERAL

1.1 SUMMARY

A. This section includes the Work necessary to completely furnish and install the screenings washer compactor system including all related equipment, material, and appurtenances as shown on the drawings and specified herein.

A. Equipment specified within the following sections shall be coordinated and supplied by a single manufacturer:
1. Section 44 42 27.20 – Screenings Washer Compactor
2. Section 46 21 26 – Step Screen
3. Section 46 21 60 – Water Sluice System

B. Related sections:
1. Section 01 33 00 – Submittals
2. Section 01 66 00 – Product Storage and Handling Requirements
3. Section 01 78 23 – Operation and Maintenance Data
4. Section 01 79 00 – Electrical Demonstration and Training
5. Section 05 50 00 – Miscellaneous Metal Fabrications
6. Division 26 – Electrical Sections

1.2 COSTS OF PRE-NEGOTIATED ITEMS

A. Owner has entered into a pre-negotiated cost agreement with the specified manufacturer for some items in this section of the specification. Refer to Attachment “A” BID FORM for more details. The pre-negotiated cost agreement and proposal from the specified manufacturer is provided as an attachment to this specification section. The Contractor shall carefully review the pre-negotiated proposal and scope of supply to determine those items required by the Contract Documents which are not part of the proposal or specified manufacturer’s scope of supply. In addition to the pre-negotiated costs indicated in Attachment "A" BID FORM, the Contractor shall include in the Lump Sum Bid Price the costs for the following:
1. All items not specifically itemized in the manufacturer’s scope of supply provided as part of the pre-negotiated proposal but required by the Contract Documents and/or necessary to provide a complete and operational system.
2. All items specifically itemized in the manufacturer’s scope of supply provided as part of the pre-negotiated proposal which are designated to be provided by others, provided by the customer, provided by the Owner, or any similar designation.
3. All labor, materials, and all other associated costs not included in the pre-negotiated proposal but required by the Contract Documents and required to provide a complete and operational system.

1.3 GENERAL

A. Equipment Numbers: 10WA001, 10WA002

B. Like items of equipment provided hereinafter shall be the end products of one manufacturer to achieve standardization of appearance, operation, maintenance, spare parts and manufacturer’s services.

C. Unit Responsibility: The Work requires that the screenings washer/compactor, local control panel, instruments, and components complete with all accessories and appurtenances be the end product of one responsible system manufacturer or responsible system supplier. Unless
otherwise indicated, the Contractor shall obtain each system from the responsible supplier of the equipment. The supplier shall furnish all components and accessories of the system to enhance compatibility, ease of operation and maintenance, and as necessary to place the equipment in operation in conformance with the specified performance, features, and functions without altering or modifying the Contractor's responsibilities under the Contract Documents. The Contractor is responsible to the Owner for providing the equipment systems as specified herein.

D. General Requirements: See Division 01, GENERAL REQUIREMENTS, which contains information and requirements that apply to the work specified herein and are mandatory for this project.

1.4 SUBMITTALS

A. General: Administrative, shop drawings, samples, quality control, and contract closeout submittals shall conform to the requirements of Section 01 33 00, SUBMITTALS.

B. In addition to the requirements of Section 01 33 00, SUBMITTALS, submit the following additional specific information:

1. Shop Drawings:
   a. Make, model, weight, and horsepower of each component.
   b. Manufacturer's catalog information, descriptive literature, specifications, and identification of materials of construction.
   c. Detailed mechanical, and electrical drawings showing the equipment fabrications and interface with other items. Include dimensions, size, and details of anchorage and of connections to other work, and weights of associated equipment.
   d. External utility requirements (quantity and connection details) such as air, water, power, drain etc., for each component.
   e. Motor nameplate data, motor manufacturer, and any motor modifications.
   f. Wiring diagrams for motors, including terminals and numbers.
   g. Suggested spare parts list to maintain the equipment in service for a period of 1 year and 5 years. Include a list of special tools required for checking, testing, parts replacement, and maintenance with current price information.
   h. List of special tools, materials, and supplies furnished with equipment for use prior to and during startup and for future maintenance.
   i. Instrumentation and Control Submittals: In conformance with Division 26, ELECTRICAL.

2. Quality Control Submittals:
   a. Manufacturer's Certificate of Compliance: Commercial products, including painting/coating systems.
   b. Special shipping, storage and protection, and handling instructions.
   c. Test procedures.
   d. Test results, reports, and certifications.
   e. Manufacturer's Certificate of Proper Installation.
   f. Operation and maintenance manual.
   g. In addition, Quality Control Submittals shall conform to the requirements of Section 01 66 00, PRODUCT STORAGE AND HANDLING REQUIREMENTS.


1.5 QUALITY CONTROL

A. The materials covered under these specifications are intended to be standard equipment of proven reliability and as manufactured by a reputable manufacturer having experience in the production of screening equipment. The equipment furnished shall be designed and constructed in accordance with the best practices and methods and shall operate satisfactorily when
installed as shown on the Contract Drawings and operated per the manufacturer’s recommendations.

B. Fabrication shall be done in compliance with all applicable ASTM standards or equivalent international standards.

1.6 OPERATION AND MAINTENANCE DATA

A. O&M Manuals: Content, format and schedule for providing as specified in Section 01 78 23, OPERATION AND MAINTENANCE DATA.

B. Maintenance Summary Forms: As specified in Section 01 78 23, OPERATION AND MAINTENANCE DATA.

1.7 WARRANTY

A. Provide warranty for a period of 12 months after the final acceptance of the equipment by the Owner and Engineer. The warranty shall stipulate that the equipment furnished is suitable for the purpose intended and free from defects of material and workmanship for the duration of the warranty. In the event the equipment fails to perform as specified, the Manufacturer will promptly repair or replace the defective equipment without additional cost to the Owner.

B. Spare parts identified within this specification shall not be used to address warranty repairs.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Where a manufacturer’s standard equipment name and/or model number is listed, the equipment system shall be provided and modified as required to conform to the performance, functions, features, and materials of construction as specified herein.

B. Materials, equipment, components, and accessories specified in this section shall be, products of:
   1. Huber Technology, Inc.

2.2 GENERAL REQUIREMENTS

A. Noise Level: When in operation, no piece of equipment shall exceed the OSHA noise level requirements for a 1 hour exposure, 105 dBA.

B. Service Factors: Service factors shall be applied in the selection and design of components where so indicated in individual sections. When not indicated there, minimum service factors shall be 1.25, except for gears and gear drives as specified herein.

C. Safety Devices: The completed work shall include all necessary permanent safety devices, such as machinery guards, emergency stops and similar items required by OSHA, and other federal, state, and local health and safety regulations.

D. Flanges and Pipe Threads: Comply with ANSI B 16.1, Class 125; or B 16.5, Class 150, unless otherwise indicated. Threaded flanges and fittings shall have standard taper pipe threads complying with ANSI/ASME B 1.20.1.

E. Bearings:
1. Conform to the standards of the Anti-Friction Bearing Manufacturers Association, Inc. (AFBMA).
2. Except where otherwise indicated, bearings of process equipment shall have a minimum L-10 life expectancy of 100,000 hours.

F. Gears and Gear Drives:
1. Except as otherwise indicated, gears shall be of the helical or spiral-bevel type, designed and manufactured in accordance with AGMA Standards, with a minimum service factor of 1.7, a minimum L-10 bearing life of 60,000 hours, and a minimum efficiency of 94 percent.
2. Gear speed reducers or increasers shall be of the enclosed type, oil- or grease-lubricated and fully sealed, with a breather to allow air to escape but keep dust and dirt out. The casing shall be of cast iron or heavy-duty steel construction with lifting lugs and an inspection cover for each gear train. An oil level sight glass and an oil flow indicator shall be provided and installed for easy reading.
3. Gears and gear drives as part of an equipment assembly shall be shipped fully assembled for field installation.
4. Material selections shall comply with AGMA values and the manufacturer's recommendations. Input and output shafts shall be properly designed for the service and load requirements. Gears shall be computer-matched for minimum tolerance variation. The output shall have two positive seals to prevent oil leakage.
5. Oil level and drain location shall be readily accessible.
6. Where gear drive input to output shafts connect to couplings or sprockets, the gear drive manufacturer shall supply matching key.

G. Anchor bolts shall be specified in Section 05 50 00, MISCELLANEOUS METAL FABRICATIONS. Number and size as recommended by manufacturer.

H. Stainless Steel: Stainless steel components shall be 316 stainless steel, or higher, as specified.

I. Nameplates: Equipment nameplates of stainless steel shall be engraved or stamped and fastened to the equipment in accessible locations with stainless steel screws or drive pins. Nameplates shall contain the manufacturer's name, model, serial number, size, characteristics, and appropriate data describing the machine performance ratings.

2.3 SUPPLEMENTS

A. See supplements to this section for additional equipment system product, component or accessory information.

2.4 SERVICE CONDITIONS

A. The screenings washer/compactor shall be located outdoors on the bottom slab of the headworks, as shown in the drawings.

B. All washer/compactor equipment, devices, and accessories shall be suitable for installation and operation outside unprotected from exposure to the atmosphere.

C. The system shall perform as specified with wash water supplied at 60 psi.

2.5 SYSTEM PERFORMANCE AND FUNCTIONAL REQUIREMENTS

A. System Definition
1. The system will consist of two (2) screenings washer/compactors with discharge chutes and associated control panels.
2. The configuration and location of the systems and their components shall be as shown on the Drawings.
3. The system shall include all components and accessories which are required for a properly and fully functioning system.

B. Washer/Compactor
1. Each washer/compactor shall receive screenings removed by the step screens from the waste stream and conveyed to the washer/compactor equipment via a hydraulic sluiceway. The screened solids shall be washed to removed organic matter from the screenings. The screenings shall then be compacted through the screw compactor and discharge through a conveyance pipe into a discharge duct to a screenings bin as shown on the Drawings.
2. The washer/compactor shall be capable of:
   a. Washing the screenings to remove fecal matter and other organics from the screenings.
   b. Feeding the washed screenings by gravity to the compactor.
   c. Dewatering and compacting the screenings.
   d. Returning all recovered water to the plant drain system.
   e. To minimize odors and nuisance, the conveyance, dewatering and compaction zones shall be completely enclosed.
   f. The spray wash system shall be enclosed such that spray water, aerosols or leakage do not contaminate the operating floor.
   g. Conveying the screenings to a container beneath the discharge duct. (See Drawings)
3. Unit Capacity: 35 ft³/hr (Minimum)
4. Minimum Screenings Volume Reduction: 60%
5. Minimum solids content of washed, dewatered screenings: 8%

2.6 EQUIPMENT AND/OR MATERIALS

A. The screenings washer/compactor shall be a motorized screw type designed to receive, convey, and compact the screenings. The washer/compactor system shall be a complete assembly including, but not limited to, the following items:
1. Inlet hopper
2. Washing chamber
3. Wash water manifold system
4. Drainage zone
5. Screw assembly
6. Compaction zone
7. Discharge chute/pipe
8. Drive unit
9. Controls

B. The system shall be designed to permit simple, easy disassembly and re-assembly of any pieces which must be removed to service the screenings washer/compactor.

C. Components:
1. Inlet Chamber: Shall be designed to direct the screenings material from the step screens into the screw housing. The inlet hopper shall be constructed of 316 stainless steel.
2. Compactor Screw: The compactor screw shall be constructed of 316 stainless steel and have a minimum outside diameter of 8-1/2". The distance between the flights shall be arranged to allow transportation into the washing zone and compaction in the dewatering zone. The final flight shall be constructed of a Hardox or equivalent hardened steel alloy for abrasion resistance. A reinforced nylon brush shall be attached to the screw for the full length of the washing zone.
3. **Screw Housing:** The screw housing shall be constructed of 316 stainless steel. The dewatering section shall incorporate anti-rotation bars (if applicable) around the complete circumference to contain screenings.

4. **Washing System:** The screening washing system shall be installed in the screw housing.

5. **Wash Sprays:** The wash zone shall include a spray wash system to wash organic residue from screenings. The wash zone spray will consist of one (1) spray header, four (4) water injection points, one (1) ball valve and one (1) solenoid valve. The solenoid valve body will be of brass construction with Buna seals. The ball valve will be of brass construction with a stainless steel ball. The system will have an output of 10 GPM at 60 psi. The spray connection will be ½ inch NPT.

6. **Flush Sprays:** The press shall include a single point spray wash system to flush organic residue trapped in the outer trough. The flushing spray will consist of one (1) spray header, one (1) ball valve and one (1) solenoid valve. The solenoid valve body will be of brass construction with Buna seals. The ball valve will be of brass construction with a stainless steel ball. The system will have an output of 15 GPM at 60 psi. The spray connection will be 1/2 inch NPT.

7. **Drain Pan:** Shall be fabricated from a minimum of 1/8 inch thick stainless steel and shall connect to the screenings washer body housing with stainless steel clasps for easy removal. The drain pan shall have a resilient seal along its top edge to from a watertight seal with the housing.

8. **Discharge Pipe:** A steel plate discharge duct or round pipe shall be flanged and bolted at the end of the compaction zone. The discharge pipe shall be constructed of 316 stainless steel. Provide Type 316 stainless steel 1/2-inch nominal size NPT half couplings with plastic pipe plugs at piping increments of 5 feet or less, to allow the addition of water to re-wet and lubricate the solids if required and applicable to manufacturer’s design. The discharge pipe shall be the configuration as shown in the Drawings. Manufacturer to provide pipe supports if needed.

9. **Drive Assembly:** The washing press shall have a continuous duty rated motor, coupled to a gear reducer. The motor shall be rated for a Class 1 Division 2 area. The motor shall have a maximum of 5 HP and be a constant speed unit rotating at a maximum of 1800 rpms. It shall be powered by 230/460 VAC, 60 Hz, 3 phase. The motor conduit box will have one (1) 1/2" NPT and one (1) 3/4" NPT conduit connection. The gear reducer will be AGMA class II (1.6 service factor) with minimum 94% efficiency, producing an output speed of 14 rpm and an output torque of 13,900 inch-pounds. Heavy duty tapered roller bearings in the gear reducer will provide a maximum thrust capacity of 6,740 pounds.

D. **A 4 inch (minimum) drain line connection shall be provided to convey water from the washing system and compaction zone to the plant drain system.**

2.7 **ELECTRICAL COMPONENTS AND ACCESSORIES**

A. **General:**
1. Conform with Division 26, ELECTRICAL.
2. Provide all necessary electrical components and wiring for a complete, functional system.
3. Where indicated, motor starters shall be provided in a separate motor control center specified in Division 26, ELECTRICAL. Provide all necessary control functions to properly interface with this motor starter.

B. **Wiring:** The Drawings and Specifications indicate the anticipated wiring for the equipment provided under this section. If additional wiring is required, or if required wiring does not match what is indicated, the Contractor shall make the necessary modifications to the electrical wiring and documentation as part of the lump sum price. Wiring shall meet the requirements of Division 26, ELECTRICAL, and NFPA 70. Insulation shall be rated 600 volts, minimum. Low-voltage (24V) signals shall be run in twisted, shielded pair cable.
C. Electrical Raceways: Electrical wiring shall be installed in conduit meeting the requirements of Division 26, ELECTRICAL. Raceways shall be installed in accordance with Division 26, ELECTRICAL, and NFPA 70.

D. Spray Solenoid Valve: Each solenoid valve will have a brass body with 1/2" NPT pipe connections. Each solenoid valve requires 120 volt, 60 Hz, single phase power and will be provided with an 18 inch long integral lead. Electrical housing will be rated NEMA type 7 suitable for a Class 1, Division 2 location and provided with a 1/2" NPT conduit connection. Each solenoid valve will be field installed by the contractor in the respective wash water supply line. Proper wiring from the solenoid valve to the control panel will be the responsibility of the contractor.

E. Motors:
  1. Provide squirrel-cage ac induction motors meeting the requirements of Division 26, ELECTRICAL, and as specified herein.

2.8 INSTRUMENTATION AND CONTROLS

A. All instrumentation and control components shall be provided in accordance with the requirements of Division 40, ELECTRICAL.

B. All controls necessary for the fully automatic operation of the screenings washer/compactor shall be provided. The controls shall be designed to ensure sufficient protection against overload in order to prevent equipment damage.

C. Refer to Specification Section 46 21 26 Step Screens for control panel requirements of the complete screening system, including Waster/Compactors.

D. Control Description
   1. In the LOCAL mode:
      a. The washer/compactor will start and run continuously as long as the step screen is running. If the step screen is shut down or stopped, the washer/compactor will run for a predetermined amount of time to allow for the removal and dewatering of the screenings contained in the washer/compactor unit. When either spray wash LOCAL mode is selected, the respective solenoid valve will open or close when operator selects OPEN/CLOSE at the local control panel (LCP) selector switch and the spray wash system will run continuously when the solenoid valve is OPEN.

   2. In the REMOTE mode:
      a. The washing press shall be cycled on and off, based on the run time of the associated screen, by remote control signals from the main control panel. The washing press shall be capable of being cycled by a screen cycle counter. In AUTO the washer/compactor shall employ a cleaning cycle when signaled to stop.

2.9 TOOLS AND SPARE PARTS

A. Tools: The work includes one complete set of special tools recommended by the manufacturer for maintenance and repair of each separate type of equipment; tools shall be stored in tool boxes, and identified with the equipment number by means of stainless steel or solid plastic name tags attached to the box.

B. Spare Parts:
   1. All equipment shall be furnished with the specified manufacturers spare parts, as indicated in the individual equipment sections.
   2. Spare parts shall be tagged by project equipment number and identified as to part number, equipment manufacturer, and subassembly component (if appropriate). Spare
parts subject to deterioration such as ferrous metal items and electrical components shall be properly protected by lubricants or desiccants and encapsulated in hermetically sealed plastic wrapping. Spare parts with individual weights less than 50 pounds and dimensions less than 2 feet wide, or 18 inches high, or 3 feet in length shall be stored in a wooden box with hinged wooden cover and locking clasp. Hinges shall be strap type. The box shall be painted and identified with stenciled lettering stating the name of the equipment, equipment numbers, and the words "spare parts." A neatly typed inventory of spare parts shall be taped to the underside of the cover.

3. Provide, at a minimum, the following spare parts (in total) for the equipment:
   a. Three (3) sets of scrapers (if applicable).
   b. Nine (9) guide bars (if applicable).
   c. Three (3) sets of wear bars/strips.
   d. Three (3) solenoid valves.

2.10 FABRICATION

A. Shop Assembly: The system shall be test-run, fully assembled, in the factory before shipment. Submit test results to Engineer for review prior to shipment.

B. Shop/Factory Finishing: Shop prime coatings shall conform to the requirements of Section 09 96 00.01, HIGH-PERFORMANCE COATINGS.

PART 3 - EXECUTION

3.1 GENERAL

A. Coordination shall include space and structural requirements, clearances, utility connections, signals, outputs and features required by the manufacturer including safety interlocks.

3.2 ASSEMBLY AND PREPARATION FOR SHIPMENT

A. Each unit, including motor, shall be completely factory assembled, aligned, and securely crated for shipment. Accessory equipment which cannot be shipped assembled to the unit, such as shafts, baseplates, impellers, spare parts, and anchorage materials, shall be separately crated, clearly marked as to the contents, and shipped on the same shipment as the drives.

B. For shipment, exposed surfaces subject to rust, such as mounting flange faces, etc., shall be covered with a rust-preventive compound such as Kendall No. 5, or equal.

3.3 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. Comply with Section 01 66 00, PRODUCT STORAGE AND HANDLING REQUIREMENTS.

B. Delivery of Materials: Products shall be delivered in original, unbroken packages, containers, or bundles bearing the name of the manufacturer.

C. Storage: Products shall be carefully stored in a manner that will prevent damage and in an area that is protected from the elements.

D. Protection of Equipment: Equipment shall be boxed, crated, or otherwise protected from damage and moisture during shipment, handling, and storage. Equipment shall be protected from exposure to corrosive fumes and shall be kept thoroughly dry at all times. Pumps, motors, drives, electrical equipment, and other equipment with anti-friction or sleeve bearings shall be stored in weathertight and heated storage facilities prior to installation. For extended storage
periods, plastic equipment wrappers shall not be used to prevent accumulation of condensate in gears and bearings.

3.4 INSTALLATION

A. As shown on the Drawings. All anchors, bolts, and accessories shall be 316 stainless steel. The manufacturer shall provide templates for anchor bolt locations.

B. Contractor will install the equipment according to the Contract Documents, following the instructions detailed in the Installation Operation and Maintenance manual.

C. Lubricants: Include oil and grease for initial operation.

3.5 FIELD QUALITY CONTROL

A. Functional Testing: Prior to plant startup, all equipment described herein shall be inspected for proper alignment, quite operation, proper connection, and satisfactory performance by means of a functional test. Provide certification of test results. Tests and certification shall be as specified in Section 01 79 00, ELECTRICAL DEMONSTRATION AND TRAINING.

3.6 MANUFACTURER’S SERVICES

A. A manufacturer’s representative for the equipment specified herein shall be present at the job site for the minimum person-days listed for the services hereinunder, travel time excluded:

1. Installation, Startup, and Testing Services:
   a. 1 person for two, eight-hour days for installation assistance, inspection, and Certificate of Proper Installation.
   b. 1 person for one, eight-hour day for functional and performance testing.
   c. Provide Qualifications of Manufacturer’s employee.

2. Training Services:
   a. 1 person for one, eight-hour day of prestart classroom or jobsite training of Owner’s personnel.
   b. Training of Owner’s personnel shall be at such times and at such locations as required and approved by the Owner.

B. See Section 01 79 00, DEMONSTRATION & TRAINING of Division 01, GENERAL REQUIREMENTS.

3.7 MANUFACTURER’S CERTIFICATES

A. Provide Manufacturer’s certificate(s) in accordance with Section 01 79 00, DEMONSTRATION AND TRAINING, of Division 01, GENERAL REQUIREMENTS.

END OF SECTION
SECTION 44 42 40 – GRIT CLASSIFIER

PART 1 - GENERAL

1.1 SUMMARY

A. This section includes the Work necessary to completely furnish, install, and place into satisfactory operating condition the grit classifier units including all related equipment, material, and appurtenances as shown on the drawings and specified herein.

B. Equipment specified within the following sections shall be coordinated and supplied by a single manufacturer:
   1. Section 44 42 40 – Grit Classifier
   2. Section 44 42 56.60 – Induced Flow (Recessed Impeller) Centrifugal Pump

C. Related sections:
   1. Section 01 33 00 – Submittal Procedures
   2. Section 01 60 00 – Product Requirements
   3. Section 01 78 23 – Operation and Maintenance Data
   4. Section 01 79 00 – Demonstration and Training
   5. Section 05 50 00 – Metal Fabrications
   6. Section 09 90 00 – Painting and Protective Coatings
   7. Division 26 – Electrical

1.2 COSTS OF PRE-NEGOTIATED ITEMS

A. Owner has entered into a pre-negotiated cost agreement with the specified manufacturer for some items in this section of the specification. Refer to Attachment “A” BID FORM for more details. The pre-negotiated cost agreement and proposal from the specified manufacturer is provided as an attachment to this specification section. The Contractor shall carefully review the pre-negotiated proposal and scope of supply to determine those items required by the Contract Documents which are not part of the proposal or specified manufacturer’s scope of supply. In addition to the pre-negotiated costs indicated in Attachment “A” BID FORM, the Contractor shall include in the Lump Sum Bid Price the costs for the following:
   1. All items not specifically itemized in the manufacturer’s scope of supply provided as part of the pre-negotiated proposal but required by the Contract Documents and/or necessary to provide a complete and operational system.
   2. All items specifically itemized in the manufacturer’s scope of supply provided as part of the pre-negotiated proposal which are designated to be provided by others, provided by the customer, provided by the Owner, or any similar designation.
   3. All labor, materials, and all other associated costs not included in the pre-negotiated proposal but required by the Contract Documents and required to provide a complete and operational system.

1.3 GENERAL

A. Equipment Numbers: 10GRT101, 10GRT201, 10GRT301

B. Like items of equipment provided hereinafter shall be the end products of one manufacturer to achieve standardization of appearance, operation, maintenance, spare parts, and manufacturer’s services.

C. Unit Responsibility: The Work requires that the grit classifier, instruments, and components complete with all accessories and appurtenances be the end product of one responsible system manufacturer or responsible system supplier. Unless otherwise indicated, the Contractor shall
obtain each system from the responsible supplier of the equipment. The supplier shall furnish all components and accessories of the system to enhance compatibility, ease of operation and maintenance, and as necessary to place the equipment in operation in conformance with the specified performance, features, and functions without altering or modifying the Contractor's responsibilities under the Contract Documents. The Contractor is responsible to the Owner for providing the equipment systems as specified herein.

D. General Requirements: See Division 01, GENERAL REQUIREMENTS, which contains information and requirements that apply to the work specified herein and are mandatory for this project.

1.4 SUBMITTALS

A. General: Administrative, shop drawings, samples, quality control, and contract closeout submittals shall conform to the requirements of Section 01 33 00, SUBMITTAL PROCEDURES.

B. In addition to the requirements of Section 01 33 00, SUBMITTAL PROCEDURES, submit the following additional specific information:
   1. Shop Drawings:
      a. Make, model, weight, and horsepower of each component.
      b. Manufacturer's catalog information, descriptive literature, specifications, and identification of materials of construction.
      c. Detailed mechanical, and electrical drawings showing the equipment fabrications and interface with other items. Include dimensions, size, and details of anchorage and of connections to other work, and weights of associated equipment.
      d. Test reports demonstrating required performance at existing installations.
      e. External utility requirements (quantity and connection details) such as air, water, power, drain etc., for each component.
      f. Motor nameplate data, motor manufacturer, and any motor modifications.
      g. Wiring diagrams for motors, including terminals and numbers.
      h. Suggested spare parts list to maintain the equipment in service for a period of 1 year and 5 years. Include a list of special tools required for checking, testing, parts replacement, and maintenance with current price information.
      i. List of special tools, materials, and supplies furnished with equipment for use prior to and during startup and for future maintenance.
      j. Instrumentation and Control Submittals: In conformance with Division 26, ELECTRICAL.
   2. Quality Control Submittals:
      a. Manufacturer's Certificate of Compliance: Commercial products, including painting/coating systems.
      b. Special shipping, storage and protection, and handling instructions.
      c. Test procedures.
      d. Test results, reports, and certifications.
      e. Manufacturer's Certificate of Proper Installation.
      f. Operation and maintenance manual.
      g. In addition, Quality Control Submittals shall conform to the requirements of Section 01 60 00, PRODUCT REQUIREMENTS.

1.5 QUALITY CONTROL

A. Balancing: Rotating elements of equipment, except small, commercially packaged equipment, shall be statically and dynamically balanced at the factory prior to final assembly. The Contractor shall furnish certified copies of all test results.
1.6 OPERATION AND MAINTENANCE DATA

A. O&M Manuals: Content, format, and schedule for providing as specified in Section 01 78 23, OPERATION AND MAINTENANCE DATA.

B. Maintenance Summary Forms: As specified in Section 01 78 23, OPERATION AND MAINTENANCE DATA.

1.7 WARRANTY

A. The manufacturer shall warranty the equipment furnished under this section to be free from defects in material and workmanship for a period of twelve (12) months after issuance of substantial completion by the Owner and Engineer. If any warranted material defects are found to exist, the supplier will promptly repair or replace the defective material without additional cost to the Owner.

B. Spare parts identified within this specification shall not be used to address warranty repairs.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Where a manufacturer’s standard equipment name and/or model number is listed, the equipment system shall be provided and modified as required to conform to the performance, functions, features, and materials of construction as specified herein.

B. Materials, equipment, components, and accessories specified in this section shall be, products of:

1. WEMCO

2.2 GENERAL REQUIREMENTS

A. Noise Level: When in operation, no piece of equipment shall exceed the OSHA noise level requirements for a 1 hour exposure, 105 dBA.

B. Service Factors: Service factors shall be applied in the selection and design of components where so indicated in individual sections. When not indicated there, minimum service factors shall be 1.25, except for gears and gear drives as specified herein.

C. Safety Devices: The completed work shall include all necessary permanent safety devices, such as machinery guards, emergency stops and similar items required by OSHA, and other federal, state, and local health and safety regulations.

D. Flanges and Pipe Threads: Comply with ANSI B 16.1, Class 125; or B 16.5, Class 150, unless otherwise indicated. Threaded flanges and fittings shall have standard taper pipe threads complying with ANSI/ASME B 1.20.1.

E. Bearings:

1. Conform to the standards of the Anti-Friction Bearing Manufacturers Association, Inc. (AFBMA).

2. Except where otherwise indicated, bearings of process equipment shall have a minimum L-10 life expectancy of 100,000 hours.

F. Gears and Gear Drives:
1. Except as otherwise indicated, gears shall be of the helical or spiral-bevel type, designed and manufactured in accordance with AGMA Standards, with a minimum service factor of 1.7, a minimum L-10 bearing life of 60,000 hours, and a minimum efficiency of 94 percent.

2. Gear speed reducers or increasers shall be of the enclosed type, oil- or grease-lubricated and fully sealed, with a breather to allow air to escape but keep dust and dirt out. The casing shall be of cast iron or heavy-duty steel construction with lifting lugs and an inspection cover for each gear train. An oil level sight glass and an oil flow indicator shall be provided and installed for easy reading.

3. Gears and gear drives as part of an equipment assembly shall be shipped fully assembled for field installation.

4. Material selections shall comply with AGMA values and the manufacturer's recommendations. Input and output shafts shall be properly designed for the service and load requirements. Gears shall be computer-matched for minimum tolerance variation. The output shall have two positive seals to prevent oil leakage.

5. Oil level and drain location shall be readily accessible. Oil coolers or heat exchangers with all required appurtenances shall be included where indicated.

6. Where gear drive input to output shafts connect to couplings or sprockets, the gear drive manufacturer shall supply matching key.

G. Anchor bolts shall be specified in Section 05 50 00, METAL FABRICATIONS. Number and size as recommended by manufacturer.

H. Stainless Steel: Stainless steel components shall be 304 stainless steel, or higher, as specified.

I. Nameplates: Equipment nameplates of stainless steel shall be engraved or stamped and fastened to the equipment in accessible locations with stainless steel screws or drive pins. Nameplates shall contain the manufacturer's name, model, serial number, size, characteristics, and appropriate data describing the machine performance ratings.

2.3 SUPPLEMENTS

A. See supplements to this section for additional equipment system product, component, or accessory information.

2.4 SERVICE CONDITIONS

A. Grit will be removed from the screened wastewater in the vortex grit chamber. Grit pumps will transfer grit from the bottom of the grit chamber to the grit classifier. The classifier will discharge grit into a chute/dumpster for disposal and return overflow to the main process flow.

B. All grit classifier equipment, devices, and accessories shall be suitable for installation and operation outside unprotected from exposure to the atmosphere. The equipment shall be designed for ambient temperatures ranging from −10°F to 120°F.

2.5 SYSTEM PERFORMANCE AND FUNCTIONAL REQUIREMENTS

A. The grit classifier system shall consist of the following components:
   1. Three (3) WEMCO Hydrogritter classifier units
   2. Three (3) Wemclone Cyclones

B. Operating conditions
   1. Number of Units: 3
C. Performance
1. Minimum capture rate (retainage) of equal to or larger than 100 mesh at 250 gpm: 95%
2. Minimum capture rate (retainage) of equal to or larger than 100 mesh at minimum underflow capacity: 95%.

D. Grit Cyclone
1. The grit cyclone separator will be mounted on top of the Hydrogritter classifier.
2. Grit is pumped into the cyclone, where approximately 95% of the grit is captured and separated. The de-gritted flow exits the top of the cyclone and flows to the plant drain while the grit concentrate from the cyclone underflow is discharged into the grit classifier unit.
3. The cyclone will be equipped with a minimum 4" flanged inlet connection and a minimum 6" flanged outlet connection.

E. Grit Classifier
1. The grit classifier shall consist of a specially designed screw conveyor which shall discharge dewatered grit into a dumpster. The spout and screw shall be designed to provide an acceptable clearance above the dumpster or discharge chute.
2. The conveyor screw shall consist of sectional flights welded to a continuous stainless steel pipe shaft. The flights must also contain replaceable abrasion resistant wearing shoes or replenishable hard facing. The screw will rotate at a maximum speed of 12 rpm.
3. The maximum screw length for dewatering grit shall be 15 feet.
4. Overflow from the screw shall be routed to the floor drainage system. A drain connection with a valve shall be provided at the lower end of the screw to allow dewatering of the classifier reservoir. Drain piping shall be provided from the classifier drain to the overflow piping. Openings in the dewatering screw housing shall be reinforced with additional plate thickness at drain and overflow connections. The chamber will be provided with a minimum 2-inch OD flanged discharge pipe for the overflow.
5. The drive unit for the grit classifier shall consist of a motor, gear reducer, and V-belt drive. The motor shall be no smaller than 0.5 hp.
6. Stalling of the grit dewatering screw shall not cause damage to the equipment. The equipment shall be protected by a load current relay with hand reset contacts which can be set to stop at any desired load. The load current relay and associated CTs shall be provided by the equipment manufacturer for installation in the motor control center starter. The equipment supplier shall provide recommended settings for adjustable load current relay. Shear pins shall not be used.
7. If a submerged auger is provided, the entire motor, drive, screw conveyor, and lower bearing assembly shall be designed so that the screw can be raised for inspection and bearing replacement without the need to disassemble any components, or to drain the classifier tank.

2.6 EQUIPMENT AND/OR MATERIALS
A. General
1. Welding: All welded joints which will be fully or partially submerged shall be sealed watertight by continuous welds.
2. Edge Grinding: Sharp projects of cut or sheared edges of ferrous metals which will be submerged in operation shall be ground to a radius by multiple passes of a power grinder as required to ensure satisfactory paint adherence.
3. Stainless Steel: All welds in stainless steel subassemblies shall be electrochemically cleaned or acid passivated after welding for corrosion resistance and to provide a superior finish. This shall be done by electrochemically removing heat tint and discoloration with a device designed for that purpose or by full dipping of weldments; or by using an acid passivation paste in the weld and heat affected areas and spray on acid solutions elsewhere. After passivation, the weldments shall be thoroughly rinsed with clean water and allowed
to air dry. No heat tint or carbon steel contamination shall be evident after this process. If there is contamination evident, the contaminated areas will be cleaned by the above method and rechecked after rinsing and drying. Sandblasting, bead blasting, or grit blasting of stainless steel surfaces shall not be allowed in lieu of the above procedures. The motor and reducer will be provided with the manufacturer’s standard finish.

4. Surface Preparation: All welds shall be thoroughly cleaned and ground smooth in preparation for painting. All ferrous metal surfaces, except motors, speed reducers, and stainless steel, shall be cleaned in accordance with paint manufacturer recommendations before shop primer is applied.

5. Bolts and Anchor Bolts: All assembly and anchor bolts, nuts, and washers shall be 316 stainless steel. An anti-seize thread compound shall be applied to all field installed nuts and bolts.

B. Grit Cyclone
1. The grit cyclone shall be constructed of aluminum and shall be lined with rubber. Cyclone hardware shall be constructed of stainless steel.
2. The structural support for the cyclone shall be constructed of stainless steel.
3. A stainless steel pressure gauge shall be attached with a pressure range of 0-15 psi.

C. Classifier
1. Screw
   a. The screw shall be constructed of 304 stainless steel.
   b. The screw shall be a minimum of 12” diameter.
   c. The housing for the grit dewatering conveyor shall be 304 stainless steel.
2. Drive Shaft
   a. The Grit Dewatering Conveyor shall be provided with a drive unit consisting of the motor and the helical gear reducer, mounted as a single integrated unit.
   b. The inlet shaft bearing shall be capable of being greased, if required.
   c. The drive shaft shall be mounted on a plate at the discharge end and the plate shall be bolted to the flanges on the trough.
   d. The helical gear reducer shall have hardened alloy steel gears accurately cut to shape.
3. Tank Assembly
   a. The tank walls shall be a minimum of 3/16 inch thick and constructed of 304 stainless steel.
   b. A full length overflow weir trough will be provided to return water to the plant drain.

D. Anchor Bolts
1. Equipment manufacturer shall furnish all anchor bolts of ample size and strength required to securely anchor each item of equipment. Anchor bolts, hex nuts, and washers shall be stainless steel. Anchor bolts shall be wedge or epoxy type.
2. Anchor bolts shall be set by the contractor. Equipment shall be placed on the foundations, leveled, shimmed, bolted down, and grouted with a non-shrinking grout.

2.7 ELECTRICAL COMPONENTS AND ACCESSORIES

A. General:
1. Conforms to Division 26, ELECTRICAL.
2. Provide all necessary electrical components and wiring for a complete, functional system.
3. Where indicated, motor starters shall be provided in a separate motor control center specified in Division 26, ELECTRICAL. Provide all necessary control functions to properly interface with this motor starter.
B. Wiring: The Drawings and Specifications indicate the anticipated wiring for the equipment provided under this section. If additional wiring is required, or if required wiring does not match what is indicated, the Contractor shall make the necessary modifications to the electrical wiring and documentation as part of the lump sum price. Wiring shall meet the requirements of Division 26, ELECTRICAL, and NFPA 70. Insulation shall be rated 600 volts, minimum. Low-voltage (24V) signals shall be run in twisted, shielded pair cable.

C. Electrical Raceways: Electrical wiring shall be installed in conduit meeting the requirements of Division 26, ELECTRICAL. Raceways shall be installed in accordance with Division 26, ELECTRICAL, and NFPA 70.

D. Motors:
1. Provide squirrel-cage ac induction motors meeting the requirements of Division 26, ELECTRICAL, and as specified herein.
2. For additional specific requirements on motors, refer to the Motor Data Sheets at the end of the Section.

2.8 INSTRUMENTATION AND CONTROLS

A. All instrumentation and control components shall be provided in accordance with the requirements of Division 40.

B. Other Instrumentation and Controls: Provide all items not specifically called out which are required to implement the functions described herein.

2.9 TOOLS AND SPARE PARTS

A. Tools: The work includes one complete set of special tools recommended by the manufacturer for maintenance and repair of each separate type of equipment; tools shall be stored in tool boxes, and identified with the equipment number by means of stainless steel or solid plastic name tags attached to the box.

B. Spare Parts:
1. Provide manufacturers recommended spare parts for each piece of equipment specified. At a minimum provide:
   a. Two (2) cyclone liners per unit provided.
   b. Provide one (1) complete set of grit screw wear plates, if required, UHMW guides, and bearings.
2. Spare parts shall be tagged by project equipment number and identified as to part number, equipment manufacturer, and subassembly component (if appropriate). Spare parts subject to deterioration such as ferrous metal items and electrical components shall be properly protected by lubricants or desiccants and encapsulated in hermetically sealed plastic wrapping. Spare parts with individual weights less than 50 pounds and dimensions less than 2 feet wide, or 18 inches high, or 3 feet in length shall be stored in a wooden box with hinged wooden cover and locking clasp. Hinges shall be strap type. The box shall be painted and identified with stenciled lettering stating the name of the equipment, equipment numbers, and the words “spare parts.” A neatly typed inventory of spare parts shall be taped to the underside of the cover.

2.10 FABRICATION

A. Shop Assembly: The system shall be factory assembled and tested.

B. Shop/Factory Finishing: Shop prime coatings shall conform to the requirements of Section 09 90 00, PAINTING AND PROTECTIVE COATINGS.
PART 3 - EXECUTION

3.1 GENERAL

A. Coordination shall include space and structural requirements, clearances, utility connections, signals, outputs, and features required by the manufacturer including safety interlocks.

3.2 ASSEMBLY AND PREPARATION FOR SHIPMENT

A. Each drive unit, including motor, shall be completely factory assembled, aligned, and securely crated for shipment. Accessory equipment which cannot be shipped assembled to the unit, such as shafts, baseplates, impellers, spare parts, and anchorage materials, shall be separately crated, clearly marked as to the contents, and shipped on the same shipment as the drives.

B. For shipment, exposed surfaces subject to rust, such as mounting flange faces, etc., shall be covered with a rust-preventive compound such as Kendall No. 5, or equal.

3.3 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. Comply with Section 01 60 00, PRODUCT REQUIREMENTS.

B. Delivery of Materials: Products shall be delivered in original, unbroken packages, containers, or bundles bearing the name of the manufacturer.

C. Storage: Products shall be carefully stored in a manner that will prevent damage and in an area that is protected from the elements.

D. Protection of Equipment: Equipment shall be boxed, crated, or otherwise protected from damage and moisture during shipment, handling, and storage. Equipment shall be protected from exposure to corrosive fumes and shall be kept thoroughly dry at all times. Pumps, motors, drives, electrical equipment, and other equipment with anti-friction or sleeve bearings shall be stored in weathertight and heated storage facilities prior to installation. For extended storage periods, plastic equipment wrappers shall not be used to prevent accumulation of condensate in gears and bearings.

3.4 FIELD QUALITY CONTROL

A. Functional Testing: Six-hour continuous flow through operation test with grit through the grit classifier. Provide certification of test results. Tests and certification shall be as specified in Section 01 79 00, ELECTRICAL DEMONSTRATION AND TRAINING.

3.5 INSTALLATION

A. As shown on the Drawings. All anchors, bolts, and accessories shall be 316 stainless steel. The manufacturer shall provide templates for anchor bolt locations.

B. Lubricants: Include oil and grease for initial operation.

3.6 MANUFACTURER’S SERVICES

A. A manufacturer’s representative for the equipment specified herein shall be present at the job site for the minimum person-days listed for the services hereunder, travel time excluded:

1. Installation, Startup, and Testing Services:
   a. 1 person-day for installation assistance, inspection, and Certificate of Proper Installation.
b. 1 person-day for functional and performance testing.
c. Provide Qualifications of Manufacturer's Representative.

2. Training Services:
a. 1 person-day of prestart classroom or jobsite training of Owner's personnel.
b. Training of Owner's personnel shall be at such times and at such locations as required and approved by the Owner.

B. Provide Manufacturer's service(s) in accordance with Section 01 79 00, DEMONSTRATION AND TRAINING of Division 01, GENERAL REQUIREMENTS.

3.7 MANUFACTURER'S CERTIFICATES

A. Provide Manufacturer’s certificate(s) in accordance with Section 01 79 00, DEMONSTRATION AND TRAINING, of Division 01, GENERAL REQUIREMENTS.

3.8 SUPPLEMENTS

A. The supplements listed below, following “END OF SECTION,” are part of this Specification.
   1. 44 42 40.1 DS – Grit Screw Motor

END OF SECTION
### Section 44 42 40.1: Grit Screw Motor Data Sheet

<table>
<thead>
<tr>
<th>PROJECT:</th>
<th>Western Area WWTP Phase 1 Expansion</th>
</tr>
</thead>
<tbody>
<tr>
<td>OWNER:</td>
<td>City of Huntsville</td>
</tr>
<tr>
<td>EQUIPMENT NAME(S):</td>
<td>Grit Classifier Nos. 1 – 3</td>
</tr>
<tr>
<td>EQUIPMENT TAG NUMBER(S):</td>
<td>10GRT101, 10GRT201, 10GRT301</td>
</tr>
<tr>
<td>CONTROL PANEL(S)</td>
<td>See Drawings</td>
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</table>

#### MOTOR DATA

<table>
<thead>
<tr>
<th>Type:</th>
<th>Squirrel-cage induction meeting requirements of NEMA MG1.</th>
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</thead>
<tbody>
<tr>
<td>Manufacturer:</td>
<td>For multiple units of the same type of equipment, furnish motors and accessories of a single manufacturer.</td>
</tr>
<tr>
<td>Hazardous Location:</td>
<td>❑ Furnish motors for hazardous (classified) locations that conform to UL 674 and have an applied UL listing marking.</td>
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<tr>
<td>Motor Horsepower:</td>
<td>1.0 (Max)</td>
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<tr>
<td>Voltage:</td>
<td>460</td>
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<tr>
<td>Phase:</td>
<td>3</td>
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<tr>
<td>Frequency:</td>
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<tr>
<td>Synchronous Speed:</td>
<td>1,800 rpm</td>
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<td>Adjustable Speed Drive:</td>
<td>Provide Inverter Duty Rated Motors.</td>
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<td>Multispeed, Two Speed:</td>
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<td>Load Class:</td>
<td>Constant Torque</td>
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<tr>
<td>Enclosure Type:</td>
<td>TEFC</td>
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<tr>
<td>Material:</td>
<td>Cast Iron; A48 Class 35B</td>
</tr>
<tr>
<td>Mounting Type:</td>
<td>Horizontal ❑ Vertical</td>
</tr>
<tr>
<td>Service Factor:</td>
<td>1.0 ❑ 1.15</td>
</tr>
<tr>
<td>Motor nameplate horsepower shall not be exceeded at any operational point.</td>
<td></td>
</tr>
</tbody>
</table>

#### SPECIAL FEATURES / NOTES

- Space Heater ❑
- Oversize main terminal (conduit) box for motors
- Moisture Detection Switches
SECTION 44 42 45 – PROCESS TRAINS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes: the Work necessary to completely furnish and install the process trains equipment, all related materials, and appurtenances.

B. Related Sections:
1. Section 01 33 00 – Submittal Procedures.
2. Section 01 60 00 – Product Requirements.
3. Section 01 78 23 – Operation and Maintenance Data.
4. Section 01 79 00 – Demonstration and Training.
5. Section 09 90 00 – Painting and Protective Coatings.

1.2 OWNER FURNISHED MATERIALS

A. Owner has pre-purchased portions of the process train systems to be provided to the Contractor for installation. The detailed scope of supply for Owner furnished items is provided in the designated volume of the project documents. The Contractor shall carefully review the scope of supply to determine those items required by the Contract Documents which are not part of the proposal or specified manufacturer’s scope of supply. Costs for installation of Owner furnished materials shall be included in the relevant Lump Sum Bid Price items of the bid form and shall include costs for the following:
1. All items not specifically itemized in the Owner’s scope of supply but required by the Contract Documents and/or necessary to provide a complete and operational system.
2. All items specifically itemized in the Owner’s scope of supply which are designated to be provided by others, provided by the customer, or any similar designation.
3. All labor, materials, and all other associated costs not included in the Scope of Supply but required by the Contract Documents and required to provide a complete and operational system.

1.3 GENERAL

A. Equipment Numbers: 30MIX301, 30AER302, 30AER303

B. Like items of equipment provided hereinafter shall be the end products of one manufacturer to achieve standardization of appearance, operation, maintenance, spare parts, and manufacturer’s services.

C. Unit Responsibility: The Work requires that the Process Train equipment including mixers, aerators, gates, and components be completed with accessories and appurtenances of one responsible system manufacturer or responsible system supplier. Unless otherwise indicated, the Contractor shall obtain each system from the responsible equipment supplier. The supplier shall furnish, as necessary, all components and accessories of the system to enhance its compatibility, ease of operation, maintenance, and conformity to the specified performance, features, and functions without altering or modifying the Contractor’s responsibilities under the Contract Documents. The Contractor is responsible to the Owner for providing the equipment systems as specified herein.

D. General Requirements: See Division 01, GENERAL REQUIREMENTS, which contains information and requirements that apply to the work specified herein and are mandatory for this project.
1.4 SUBMITTALS

A. General: Administrative, shop drawings, samples, quality control, and contract closeout submittals shall conform to the requirements of Section 01 33 00, SUBMITTAL PROCEDURES.

B. In addition to the requirements of Section 01 33 00, SUBMITTAL PROCEDURES, submit the following additional specific information:
   1. Shop Drawings:
      a. Make, model, weight, and horsepower of each component.
      b. Manufacturer's catalog information, descriptive literature, specifications, and identification of materials of construction.
      c. Detailed mechanical and electrical drawings showing the equipment fabrications and interface with other items. Include dimensions, size, and details of anchorage and of connections to other work, and weights of associated equipment.
      d. Gear output torque capacity calculations.
      e. Calculations verifying that provided equipment meet criteria for the application.
      f. Hydraulic calculations and performance verification data.
      g. Performance curves.
      h. External utility requirements (quantity and connection details) such as air, water, power, and drain for each component.
      i. Motor nameplate data, motor manufacturer, and any motor modifications.
      j. Wiring diagrams for motors, including terminals and numbers.
      k. Suggested spare parts list to maintain the equipment in service for a period of 1 year and 5 years. Include a list of special tools required for checking, testing, parts replacement, and maintenance with current price information.
      l. List of special tools, materials, and supplies furnished with equipment for use prior to and during startup and for future maintenance.
      m. Instrumentation and Control Submittals: In conformance with Division 26, ELECTRICAL.

2. Quality Control Submittals:
   a. Manufacturer's Certificate of Compliance: Commercial products, including painting/coating systems.
   b. Special shipping, storage and protection, and handling instructions.
   c. Test procedures.
   d. Test results, reports, and certifications.
   e. Manufacturer's Certificate of Proper Installation.
   f. Operation and maintenance manual.


1.5 OPERATION AND MAINTENANCE DATA

A. O&M Manuals: Content, format, and schedule for providing as specified in Section 01 78 23, OPERATION AND MAINTENANCE DATA.

B. Maintenance Summary Forms: As specified in Section 01 78 23, OPERATION AND MAINTENANCE DATA.

1.6 WARRANTY

A. The warranty shall be for a minimum period of 12 months from start-up. The warranty shall stipulate that the equipment furnished is suitable for the purpose intended and free from defects of material and workmanship for the duration of the warranty. In the event the equipment fails to perform as specified, the Manufacturer shall promptly repair or replace the defective equipment without additional cost to the Owner.
B. Spare parts identified within this specification shall not be used to address warranty repairs.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Where a Manufacturer's standard equipment name and/or model number is listed, the equipment system shall be provided and modified as required to conform to the performance, functions, features, and materials of construction as specified herein.

B. Materials, equipment, and accessories specified herein shall be products of:
   1. Ovivo.

2.2 GENERAL REQUIREMENTS

A. Furnish units meeting performance and design requirements as specified and as shown on the Drawings.

2.3 VERTICAL TURBINE MIXER

A. General:
   1. Function: Mixers shall be capable of keeping solids in suspension when installed as shown on the Drawings. The mixer design shall be such that resulting air entrainment is minimized.
   2. Type: Each mixer shall be of the vertical turbine design. The propeller shall be capable of handling solids, fibrous materials, heavy sludge, and other matter found in sanitary sewage applications.
   3. Submergence: All components of the mixer, including motor, shall be capable of continuous operation in the following conditions:
      a. Mixer blade completely submerged.
      b. Mixer blade partly submerged in an unbalanced hydraulic loading condition.
      c. All components of the mixer blade completely unsubmerged for a minimum of 2 hours.

B. Service Factors: Service factors shall be applied in the selection and design of components where so indicated in individual sections. When not indicated there, minimum service factors shall be 1.25, except for gears and gear drives as specified herein.

C. Impeller:
   1. Impellers shall be sized and designed for operation at required mixing speed and shall not require dynamic balancing. In addition, the impellers shall be designed as necessary to suspend solids to a uniform concentration without stratification at all conditions listed on the Mixer Data Sheet. The impeller shall consume 80 to 90 percent of the mixer drive horsepower at full speed.
   2. Unless otherwise specified, the impeller hub shall be of cast construction, the fins fabricated, and shall be connected to the agitator shaft with a hook and key for maximum security. A keyway shall be provided to allow for vertical adjustment of impeller.
   3. The maximum stress in any impeller component shall not exceed 11,000 psi under maximum operating loads.
   4. The shaft-impeller system design shall be such that its operating speed shall not exceed 75 percent of its first lateral critical speed. The use of stabilizing rings or fins will not influence this limitation. The shaft shall be safe for operation when the liquid level passes through the impeller while the mixer is running.
5. The impeller shall be designed as a low shear pump to reduce adverse flocculation shear effects. The impeller shall essentially pump water with minimal air entrainment to optimize the operating stability.

6. The impeller shall consist of a minimum of six (6) equally spaced downward pumping blades. The blades shall be constructed of \( \frac{1}{4}'' \) minimum steel plate.

7. The impeller shall be designed to provide pumping in both the radial and downward axial direction to achieve the proper mixing regime. Mixer blades shall be mounted on a 45-degree angle to achieve this pattern. Mixers the only provide axial pumping will not be considered.

**D. Shaft:**
1. The impeller shaft shall be of sufficient size to safely withstand the torque and hydraulic side forces imposed by the impeller.
2. The shaft and blades shall be an integral, shop-welded unit requiring no field welding.
3. The entire impeller/shaft assembly shall be completely shop assembled and shall be dynamically balanced at a minimum of 200 rpm.
4. The impeller shaft shall be locked into the gear reducer hollow shaft with a lock-nut at the top of the gear reducer. Stainless steel fasteners are not acceptable.

**E. Bearings:**
1. Bearings shall conform to the standards of the American Bearing Manufacturers Association, Inc. (ABMA).
2. All drive bearings shall be of the antifriction type, ball, or roller bearings. The output shaft shall be supported by tapered roller bearings.
3. Except where otherwise indicated, bearings of process equipment shall have minimum ABMA L-10 lives of 100,000 hours when operating at full motor nameplate horsepower at design speed.
4. The design shall preclude the use of underwater bearings to provide the required operating stability.

**F. Gear Reducer:**
1. Except as otherwise indicated, gears shall be of the helical or spiral-bevel type, designed and manufactured in accordance with AGMA Standards, with a minimum service factor of 1.5, a minimum L-10 bearing life of 100,000 hours based on full motor nameplate horsepower, and a minimum efficiency of 94 percent. Worm gears shall not be used. Single reduction gear reducers are not acceptable.
2. Gear speed reducers or increasers shall be of the enclosed type, oil- or grease-lubricated and fully sealed, with a breather to allow air to escape but keep dust and dirt out. The casing shall be of cast iron or heavy-duty steel construction with lifting lugs and an inspection cover for each gear train. An oil level sight glass and an oil flow indicator shall be provided and installed for easy reading. An oil drain shall be provided and installed for easy access.
3. Gears and gear drives as part of an equipment assembly shall be shipped fully assembled for field installation.
4. Material selections shall comply with AGMA values and the Manufacturer's recommendations. Input and output shafts shall be properly designed for the service and load requirements. Gears shall be computer-matched for minimum tolerance variation. The output shall have two positive seals to prevent oil leakage or drywell design.
5. Oil level and drain location shall be readily accessible. Oil coolers or heat exchangers with all required appurtenances shall be included where indicated.
6. Where gear drive input to output shafts connect to couplings or sprockets, the gear drive manufacturer shall supply matching key.
7. Provide mounting bases for the mixer drive systems suitable for mounting at locations shown on the Drawings.
8. The motor and gear reducer assembly shall be run under no load conditions until the temperature stabilizes. The contractor shall be responsible for assuring proper alignment and gap tolerance as set forth in the installation instructions.

9. In the field, the contractor will prepare each gear reducer and then install the recommended lubrication oil so that start up after prolonged periods of shut-down in cold weather will not affect the unit.

G. Anti-Vortex Baffle
1. One (1) anti-vortex baffle shall be provided for each mixer. Each baffle shall be attached to the structure concrete support columns.
2. Each baffle shall be fabricated of ¼” steel plate and shall have adequate stiffness to provide the required structural rigidity.

2.4 MECHANICAL AERATORS

A. General:
1. Function: Aerators shall be capable of agitating the surface, completely mixing the contents, and inducing circulation in the aeration basin when installed as shown on the Drawings.
2. Type: Aerator units shall consist of an aerating impeller driven by an electric motor through a gear reducer. The impeller shall be capable of handling solids, fibrous materials, heavy sludge, and other matter found in sanitary sewage applications.

B. Materials: Aerator components in contact with liquid shall be steel, conforming to ASTM A36, with smooth surfaces devoid of blow holes and other irregularities. All exposed nuts, bolts, fasteners, and hardware shall be 316 stainless steel except coupling bolts which shall be A325 galvanized steel and jack studs which shall be zinc-plated carbon steel.

C. Impeller:
1. The impeller shall be ASTM A36 or 316 stainless steel and shall be specifically designed for aeration. The impeller shall be of non-clogging type and of the diameter and of the blade angle recommended by the manufacturer to provide the performance specified herein. Each blade shall be manufactured with quality control measures necessary to ensure that the impeller is properly balanced.
2. The impeller shall be designed so that flooding during operation does not cause permanent damage to the aerator but may cause interruption of power supply by the motor overload devices, provided that overload devices interrupt the power supply as intended.
3. The horsepower drawn by the impeller shall be approximately proportional to liquid level without more than 10% reduction in oxygen mass transfer rate per horsepower below the rate at maximum horsepower. At the minimum liquid level, the horsepower required by the impeller shall not exceed 70% of the horsepower required at the maximum liquid level.
4. The impeller assembly shall consist of a surface and submerged impeller connected to a common shaft. The surface impeller shall provide oxygenation and propulsion of the mixed liquor at the bottom portion of the oxidation ditch. The submerged radial impeller shall provide additional propulsion of the mixed liquor at the bottom portion of the oxidation ditch.
5. Each surface impeller shall be a rim-blade type with ten (10) equally spaced blades and constructed of ¼” minimum steel plate. The rim plate shall be submerged at all operating conditions, except during basin draining operations, to reduce the effects of variable loading on the aerator support structure and deck. The impeller blades and disc shall be an integral, shop welded unit requiring no field assembly or welding.
6. Each submerged radial impeller shall consist of radial pumping blades and hub that shall be an integral, shop welded unit requiring no field assembly or welding.

D. Bearings: The gear reducers shall rotate on permanently lubricated bearings. No bearings shall be located below the bottom of the supporting platform. The bearings shall have a minimum L-10 rated life of 100,000 hours.
E. Gear Reducers:
1. Each aerator shall be provided with a two- or three-stage crossed (helical) cylindrical gear, with high precision low-loaded gears designed for infinite life. An overall minimum service factor of 2.5 should be used, based on the sum of the continuous loads plus any transient loads other than starting loads. The efficiency shall not be less than 94 percent based on the gear reducer input horsepower. The gear reducer shall have an independent lower bearing that is external to the gear box housing to accommodate an oversized shaft/bearing assembly.
2. The gear reducers shall be designed for vertical input and output shaft operation. The housing shall be cast iron construction.
3. Each gear reducer shall be provided with a thermostatically controlled heating assembly capable of preventing condensations and maintaining the manufacturer’s recommended lubricating oil at a temperature sufficient to prevent clogging at ambient temperatures as low as -40°F. The heating assembly shall be complete with heating elements, thermostat for low temperature control, and separate contactor if thermostat is not adequate for direct connection. The heating assembly shall be suitable for operation on 120 volt, 60 Hz, 1 phase power supply. The heater contactor shall be mounted in a NEMA 4X stainless steel enclosure with the aerator starter as indicated on the drawings.
4. Each gear reducer shall be equipped with an oil level indicator. Oil drains and fill openings shall be easily accessible and shall allow for filling and for convenient collection of waste oil in containers, from the platform, without removing the unit from its normal installed position. Units with the oil drain above the operating platform shall be provided with a drain valve with a ¾-inch quick disconnect male coupling adaptor to facilitate oil changing.
5. When a pumped oil lubrication system is used, each unit shall be equipped with an oil screen and either a low oil pressure cutoff switch or an oil flow indicator and cutoff switch to stop the motor and cause an alarm in the event of loss of oil pressure or flow. The switches shall be weatherproof with a normally open and a normally closed, isolated individually adjustable, 5 ampere, 120 volt ac contacts. Alarms shall be integrated into the plantwide SCADA system.

F. Coupling: Required between motor and gear unit. Statically balanced. Designed to transmit full torque of the motor. Accurately machined on all facing surfaces.

G. Shafts:
1. The rotative speed shall not exceed 40% of the critical speed of the shaft. Each aerator shaft shall be equipped with a flange coupling and shall be rigidly attached to the output shaft of the gear reducer.
2. Each aerator shaft shall be designed to be detached and replaced without emptying the basin. Each aerator shaft and impeller assembly shall be dynamically stable during operation in air, during filling or emptying of the basin, and under all operating conditions specified.
3. Output shaft shall be enclosed in a drywell which provides positive leakproof sealing.
4. Shaft Couplings:
   a. Aerator shaft couplings shall be designed to maintain alignment between shaft sections and to transmit 200% of the full load torque by means of friction between the coupling faces at the recommended bolt tightness and, at the same time, 150% of axial load on the couplings.
   b. The aerator shaft shall be attached to the gear reducer by a rigid, cast iron flange-type coupling. A retainer plate shall be provided for mounting to the end of the gear reducer output shaft to provide protection against disengagement of the coupling from the gear reducer output shaft.

H. Vibration: Aerators shall not transmit to the structure vibration levels in excess of 0.28 in/sec peak velocity when measured with a suitable vibration measuring instrument over the normal operating frequency range of 2 Hz to 1,000 Hz.
I. Mounting Assembly:
   1. Each drive unit shall be designed and mounted so that the motor and gear reducer can be removed and handled separately. The reducer housing shall provide a rigid, substantial mounting base and shall be anchored into the platform supporting members. The reducer shall be supported on an assembly of jacking screws and steel baseplate. Jacking screws shall provide for a vertical adjustment of approximately 6 inches. The baseplate shall be at least 1-1/4 inches thick.
   2. The mounting arrangement of each aerator shall be interchangeable with all other units.

J. Mist and Spray Protection: Under all operating conditions, liquid or spray shall not be thrown outside the basin nor shall mist or fine spray cause moisture or ice to collect on adjacent equipment, walkways, or other structures.

2.5 FLOW CONTROL GATE

A. General:
   1. Function: Direct and control flow from the Process Train aeration basins to the upstream anoxic basins in accordance with the process design and Operation & Maintenance instructions for the Process Trains.
   2. Type: Handwheel driven, gear drive gates with 112.5° travel in the forward and reverse direction.

B. Materials: Gate components in contact with liquid shall be 316 stainless steel. All exposed nuts, bolts, fasteners, and hardware shall be 316 stainless steel.

C. Gear Reducer:
   1. The gear operator shall be of heavy-duty construction, totally enclosed in a cast iron housing and provided with adequate seals to protect the interior of the housing. The housing shall be designed so that all gears and bearings are grease packed and factory sealed to prevent condensate formation. The gear shall be designed to operate under the full load as applied from the rotating gate. The reducer shall be equipped with a 20" steel hand wheel and require no more than 25 revolutions to rotate the gate a full 112.5° in one direction.
   2. The gear reducer shall have the ability to backdrive without locking.

D. Gate Components:
   1. The reducer mechanism shall be fitted to the gate shaft with a sleeve and key for ease of assembly and disassembly.
   2. The reducer shall be supported on a steel stand that is anchored to the concrete floor or side wall by cinch type 303 stainless steel anchors. The stand shall be of proper height to allow the operator a convenient grip on the handle for clockwise or counterclockwise turning.

E. Rotating Gate Assembly:
   1. Each gate shall be constructed from 1/4-inch steel plate properly stiffened with rib extensions and end flares. Each gate shall include a revolving shaft assembly fixed between guide bearings mounted to the floor and stand. The floor bearing shall support the entire weight of the unit. The upper guide bearing shall be an integral part of the support stand. The center guide bearing, if required by the shaft length, shall be mounted just above the water surface on the lower part of the shaft and shall be field aligned after installation of all other components, assuring proper rotational capability.
   2. The revolving shaft shall be supported at each end in such a manner that a slight vertical or horizontal misalignment shall not interfere with the smooth operation of the gate. The shaft shall revolve from the turning of the gear unit.
   3. Each gate shall be designed to operate smoothly under the flow conditions existing in the aeration basin. The gate shall include a position lock, lock pin with retention chain and shall
be adequate in 22.5° increments over a 112.5° range. The gate shall include a wall stop bracket, complete with stainless steel wall anchors.

2.6 ELECTRICAL COMPONENTS AND ACCESSORIES

A. General:
1. Conform to Division 26, ELECTRICAL.
2. Provide all necessary electrical components and wiring for a complete, functional system.
3. Where indicated, motor starters for constant-speed, 460-volt motors shall be provided in a separate motor control center specified in Division 26, ELECTRICAL. Provide all necessary control functions to properly interface with the motor starter.

B. Wiring: The Drawings and Specifications indicate the anticipated wiring for the equipment provided under this section. If additional wiring is required, or if required wiring does not match what is indicated, the Contractor shall make the necessary modifications to the electrical wiring and documentation. Wiring shall meet the requirements of Division 26, ELECTRICAL, and NFPA 70. Insulation shall be rated 600 volts, minimum. Low-voltage (24V) signals shall be run in twisted, shielded pair cable.

C. Electrical Raceways: Electrical wiring shall be installed in conduit meeting the requirements of Division 26, ELECTRICAL. Raceways shall be installed in accordance with Division 26, ELECTRICAL, and NFPA 70.

2.7 INSTRUMENTATION AND CONTROLS

A. All instrumentation and control components shall be provided in accordance with the requirements of Division 26, ELECTRICAL, and Division 40, PROCESS INTEGRATION.

2.8 ACCESSORIES

A. Lifting Lugs: Equipment weighing over 100 pounds shall be provided with lifting lugs.

B. Identification Plate: A 16-gauge stainless steel identification plate shall be securely mounted on the equipment in a readily visible location. The plate shall bear the 1/4 inch die-stamped equipment identification number and equipment data.

C. Anchors: Concrete anchors shall be in conformance with Division 05, METALS. Coordinate required size and location with Shop Drawings. The Manufacturer shall design the anchoring system and provide a template for anchor bolt locations.

2.9 TOOLS AND SPARE PARTS

A. Tools: The Work includes furnishing one complete set of special tools as recommended by the manufacturer for maintenance and repair of each separate type of equipment. Tools shall be stored in toolboxes and identified with the equipment number by means of stainless steel or solid plastic name tags attached to the box.

B. Spare Parts:
1. All equipment shall be furnished with the specified manufacturers spare parts as indicated in the individual equipment sections.
2. Spare parts shall be tagged by project equipment number and identified as to part number, equipment manufacturer, and subassembly component (if appropriate). Spare parts subject to deterioration such as ferrous metal items and electrical components shall be properly protected by lubricants or desiccants and encapsulated in hermetically sealed plastic wrapping. Spare parts with individual weights less than 50 pounds and dimensions
less than 2 feet wide or 18 inches high or 3 feet in length shall be stored in a wooden box with hinged wooden cover and locking clasp. Hinges shall be strap type. The box shall be painted and identified with stenciled lettering stating the name of the equipment, equipment numbers and the words "spare parts." A neatly typed inventory of spare parts shall be taped to the underside of the cover.

2.10 FABRICATION

A. Shop Assembly: The system shall be factory assembled and tested.
B. Shop/Factory Finishing: Shop prime coatings shall conform to the requirements of Section 09 90 00, PAINTING AND PROTECTIVE COATINGS.

PART 3 - EXECUTION

3.1 ASSEMBLY AND PREPARATION FOR SHIPMENT

A. Each drive unit, including motor, shall be completely factory assembled, aligned, and securely crated for shipment. Accessory equipment which cannot be shipped assembled to the unit, such as shafts, baseplates, propellers, impellers, spare parts, and anchorage materials, shall be separately crated, clearly marked as to the contents, and shipped on the same shipment as the drives.
B. For shipment, exposed surfaces subject to rust, such as mounting flange faces, etc., shall be covered with a rust-preventive compound such as Kendall No. 5, or equal.

3.2 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. Comply with Section 01 60 00, PRODUCT REQUIREMENTS.
B. Delivery of Materials: Products shall be delivered in original, unbroken packages, containers, or bundles bearing the name of the manufacturer.
C. Storage: Products shall be carefully stored in a manner that will prevent damage and in an area that is protected from the elements.
D. Protection of Equipment: Equipment shall be boxed, crated, or otherwise protected from damage and moisture during shipment, handling, and storage. Equipment shall be protected from exposure to corrosive fumes and shall be always kept thoroughly dry. Mixers, Aerators, motors, drives, electrical equipment, and other equipment with anti-friction or sleeve bearings shall be stored in weathertight and heated storage facilities prior to installation. For extended storage periods, plastic equipment wrappers shall not be used to prevent accumulation of condensate in gears and bearings.
E. For shipment, exposed surfaces subject to rust, such as mounting flange faces, etc., shall be covered with a rust-preventive compound such as Kendall No. 5, or equal. The equipment shall also be plastic shrink-wrapped for dust protection.

3.3 INSTALLATION

A. As shown on the Drawings. Installation shall be by the Contractor with coordination from Manufacturer.
B. Anchor Bolts: Provide templates and specify bolts for furnishing by Contractor.
C. Manufacturer shall coordinate with Contractor during all phases of installation to ensure that manufacturer’s representative is present during critical installation operations.

3.4 FIELD QUALITY CONTROL

A. All work shall conform to manufacturer’s recommendations.

B. Equipment testing shall be as follows:
   1. Check for proper installation and performance of all components.
   2. Check for proper alignment, tolerances, and any excessive noise or vibration.
   3. Check for proper lubrication.

C. Performance Testing:
   1. Conduct on each completed assembly in accordance with accepted test procedures.
   2. Perform after installation in the new basin. All equipment shall be tested simultaneously.
   3. Water required for testing shall be furnished by the Contractor and may be potable water, treated water, or untreated water. If untreated water is used, Contractor agrees to dispose of material off-site if Process Trains cannot provide proper treatment. The contractor shall provide all other support facilities which shall include, but not be limited to, power, equipment, and measuring instruments.
   4. At least two weeks prior to the proposed testing date, the Contractor shall notify the Engineer of the testing date and shall submit a report from the equipment manufacturer detailing the proposed performance testing and analyses.
   5. Testing shall be performed between 8:00 am and 5:00 pm and shall begin on Monday or Tuesday. If more than one day of testing is required, the testing shall be done on consecutive days.
   6. The data to be determined shall include, but not be limited to, balance, electric power consumption, and liquid velocities.
      a. Aerators shall be checked for balance when operating in air and when operating at maximum, minimum, and three intermediate water levels. Units shall be checked for spray and mist problems at the various operating levels.
      b. Aerators shall be checked for power requirements with a wattmeter. Aerators shall be tested throughout the operating range, and the data recorded to develop the required curve for horsepower versus impeller submergence. With all units operating, the transient power consumption of each aerator as recorded by the wattmeter shall not vary more than plus or minus 5% from the average value for that aerator.
   7. Modifications: Equipment which fails to satisfy the performance requirements shall be modified or replaced, as required. Modifications shall be made, or additional equipment shall be furnished and installed as necessary to produce an installation which will satisfy the performance requirements. The equipment shall be completely retested after modifications. Modifications and additional equipment shall be provided, retesting shall be performed, and all structural, piping, or electrical modifications necessary to accommodate the modified equipment shall be made, at no additional cost to the Owner.
   8. Procedures:
      a. Aerator speed during test will be set to most closely represented system under maximum day BOD loading.
      b. Any and all adjustments to system including additional hardware, modifications to existing hardware, and all labor, taxes, materials, fittings, etc. to meet these requirements shall be the responsibility of the Bidder.

3.5 MANUFACTURERS’ SERVICES

A. A manufacturer’s representative for the equipment specified herein shall be present at the job site for the minimum person-days listed for the services hereunder, travel time excluded:
   1. Installation, Startup, and Testing Services:
a. 1 person day for installation assistance, inspection, and Certificate of Proper Installation.
b. 1 person-day for functional and performance testing.
c. Provide Qualifications of Manufacturer's Representative.

2. Training Services:
   a. 1 person-day of prestart classroom or jobsite training of Owner's personnel.
   b. Training of Owner's personnel shall be at such times and at such locations as required and approved by the Owner.

B. See Section 01 79 00, DEMONSTRATION AND TRAINING of Division 01, GENERAL REQUIREMENTS.

3.6 MANUFACTURER’S CERTIFICATES

A. Provide Manufacturer’s certificate(s) in accordance with Section 01 79 00, DEMONSTRATION AND TRAINING.

3.7 SUPPLEMENTS

A. The supplements listed below, following “END OF SECTION,” are part of this Specification.
   1. Section 44 42 45.1 – Anoxic Basin Mixer DS.
   2. Section 44 42 45.2 – Aerators DS.

END OF SECTION
**Section 44 42 45.2: ANOXIC BASIN MIXER**

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**SPECIAL FEATURES / NOTES**

Motor Nameplate Horsepower Shall Not be Exceeded at Any Operational Point
### Section 44 42 45.2: AEROBIC BASIN AERATORS

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#### MANUFACTURER | MODEL
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Ovivo |  |

#### SERVICE CONDITIONS

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#### PERFORMANCE REQUIREMENTS

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#### EQUIPMENT DESCRIPTION

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#### MOTOR DATA

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#### SPECIAL FEATURES / NOTES

- Motor Nameplate Horsepower Shall Not be Exceeded at Any Operational Point
- Aerator Model Shall be per Manufacturer's Recommendation
SECTION 44 42 46 - SUBMERSIBLE MIXERS

PART 1 - GENERAL

1.1 SUMMARY

A. This section includes the Work necessary to completely furnish and install the submersible mixer including all related equipment, material, and appurtenances.

B. Related sections:
   1. Section 01 33 00 – Submittals
   2. Section 01 45 23 - Witnessed Factory Testing
   3. Section 01 66 00 – Product Storage and Handling Requirements
   4. Section 01 75 60 – Testing, Training, and Facility Start-Up
   5. Section 01 78 23 – Operation and Maintenance Data
   6. Section 01 79 00 – Electrical Demonstration and Training
   7. Division 05 – Metals
   8. Section 09 96 00 – Painting and Protective Coatings
   9. Division 26 – Electrical

1.2 COSTS OF PRE-NEGOTIATED ITEMS

A. Owner has entered into a pre-negotiated cost agreement with the specified manufacturer for some items in this section of the specification. Refer to Attachment “A” BID FORM for more details. The pre-negotiated cost agreement and proposal from the specified manufacturer is provided as an attachment to this specification section. The Contractor shall carefully review the pre-negotiated proposal and scope of supply to determine those items required by the Contract Documents which are not part of the proposal or specified manufacturer’s scope of supply. In addition to the pre-negotiated costs indicated in Attachment “A” BID FORM, the Contractor shall include in the Lump Sum Bid Price the costs for the following:
   1. All items not specifically itemized in the manufacturer’s scope of supply provided as part of the pre-negotiated proposal but required by the Contract Documents and/or necessary to provide a complete and operational system.
   2. All items specifically itemized in the manufacturer’s scope of supply provided as part of the pre-negotiated proposal which are designated to be provided by others, provided by the customer, provided by the Owner, or any similar designation.
   3. All labor, materials, and all other associated costs not included in the pre-negotiated proposal but required by the Contract Documents and required to provide a complete and operational system.

1.3 GENERAL

A. Equipment Numbers: 20MIX101, 20MIX201

B. Like items of equipment provided hereinafter shall be the end products of one manufacturer to achieve standardization of appearance, operation, maintenance, spare parts and manufacturer’s services.

C. Unit Responsibility: The Work requires that the submersible mixer, portable davit crane and components, complete with all accessories and appurtenances be the end product of one responsible system manufacturer or responsible system supplier. Unless otherwise indicated, the Contractor shall obtain each system from the responsible supplier of the equipment, which supplier shall furnish all components and accessories of the system to enhance compatibility, ease of operation and maintenance, and as necessary to place the equipment in operation in conformance with the specified performance, features, and functions without altering or modifying
the Contractor’s responsibilities under the Contract Documents. The Contractor is responsible to the Company and Owner for providing the equipment systems as specified herein.

D. General Requirements: See Division 01, GENERAL REQUIREMENTS, which contains information and requirements that apply to the work specified herein and are mandatory for this project.

1.4 SUBMITTALS

A. General: Administrative, shop drawings, samples, quality control, and contract closeout submittals shall conform to the requirements of Section 01 33 00, SUBMITTALS.

B. In addition to the requirements of Section 01 33 00, SUBMITTALS, submit the following additional specific information:

1. Shop Drawings:
   a. Make, model, weight, and horsepower of each component.
   b. Manufacturer's catalog information, descriptive literature, specifications, and identification of materials of construction.
   c. Detailed mechanical, and electrical drawings showing the equipment fabrications and interface with other items. Include dimensions, size, and details of anchorage and of connections to other work, and weights of associated equipment.
   d. Gear output torque capacity calculations.
   e. Calculations verifying that provided mixer meets mixing criteria for the application.
   f. Performance curves.
   g. External utility requirements (quantity and connection details) such as air, water, power, drain etc., for each component.
   h. Motor nameplate data, motor manufacturer, and any motor modifications.
   i. Wiring diagrams for motors, including terminals and numbers.
   j. Suggested spare parts list to maintain the equipment in service for a period of 1 year and 5 years. Include a list of special tools required for checking, testing, parts replacement, and maintenance with current price information.
   k. List of special tools, materials, and supplies furnished with equipment for use prior to and during startup and for future maintenance.
   l. Operation and maintenance manual.

2. Instrumentation and Control Submittals: In conformance with Division 26, ELECTRICAL.

3. Quality Control submittals:
   a. Manufacturer's Certificate of Compliance: Commercial products, including painting/coating systems.
   b. Special shipping, storage and protection, and handling instructions.
   c. Test procedures.
   d. Test results, reports, and certifications.
   e. Manufacturer's Certificate of Proper Installation
   f. Operation and maintenance manual.
   g. In addition, Quality Control Submittals shall conform to the requirements of Section 01 66 00, PRODUCT STORAGE AND HANDLING REQUIREMENTS.


1.5 QUALITY CONTROL

A. The materials covered under these specifications are intended to be standard equipment of proven reliability and as manufactured by a reputable manufacturer having experience in the production of screening equipment. The equipment furnished shall be designed and constructed in accordance with the best practices and methods and shall operate satisfactorily when installed as shown on the Contract Drawings and operated per the manufacturer’s recommendations.
B. Fabrication shall be done in compliance with all applicable ASTM standards or equivalent international standards.

C. Mixers shall be tested at the factory.
   1. Verify that propeller, motor rating, and electrical connections comply with this Section.
   2. Measure for moisture content and insulation defects in motor and cable, both before and after the submergence test.
   3. Run mixer dry to verify proper rotation and alignment.
   4. Run mixer submerged at least 30 minutes under at least 6 feet of water to check for balance, unusual noise, and overheating. Verify actual mixer thrust is appropriate for the design points.
   5. Test motor for no-load current at rated voltage and high potential.

D. A factory test report shall be submitted to the Engineer for review prior to shipment.

1.6 OPERATION AND MAINTENANCE DATA

A. O&M Manuals: content, form and schedule for providing as specified in Section 01 78 23, OPERATION AND MAINTENANCE DATA.

B. Maintenance Summary Forms: As specified in Section 01 78 23, OPERATION AND MAINTENANCE DATA.

1.7 WARRANTY

A. Provide warranty for a period of twelve (12) months after the final acceptance of the equipment by the Company, Owner, and Engineer. The warranty shall stipulate that the equipment furnished is suitable for the purpose intended and free from defects of material and workmanship for the duration of the warranty. In the event the equipment fails to perform as specified, the Manufacturer will promptly repair or replace the defective equipment without additional cost to the Company or Owner.

B. Spare parts identified within this specification shall not be used to address warranty repairs.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Where a Manufacturer's standard equipment name and/or model number is listed, the equipment system shall be provided and modified as required to conform to the performance, functions, features, and materials of construction as specified herein.

B. Manufacturers and models of components and accessories specified herein shall be as follows:
   1. Sulzer, XRW 2121

2.2 GENERAL REQUIREMENTS

A. Provide sufficient mixing energy to ensure solids contained in the liquid remain in suspension.

B. Mixer propeller size, number of vanes, and blade angle shall be selected by the Manufacturer to provide the mixing required at low speeds.
2.3 SUPPLEMENTS

A. See supplemental data sheets to this section for additional equipment system product, component and accessory information and requirements.

2.4 SERVICE CONDITIONS

A. The submersible mixers shall be suitable for operation under the conditions shown on supplemental data sheets at end of section.

2.5 MIXER

A. General:
   1. Function:
      a. Capable of keeping solids in suspension when installed as shown on the Drawings.
      b. Shall minimize air entrainment.
   2. Type:
      a. Submersible of close-coupled design.
      b. Propeller shall be capable of handling solids, fibrous materials, heavy sludge, and other matter found in sanitary sewage applications.
   3. Submergence: All components of the mixer, including motor, shall be capable of continuous underwater operation in both of the following conditions:
      a. Mixer blade completely submerged,
      b. Mixer blade partly submerged in an unbalanced hydraulic loading condition.
      c. Components of the mixer, including motor, shall be capable of continuous operation in air, completely unsubmerged, for 2 hours minimum.

B. Materials:
   1. Components in contact with the liquid shall be of Type 316 stainless steel with smooth surfaces devoid of blowholes and other irregularities.
   2. Motor unit shall be Type 316 stainless steel; cast-iron body with 316 stainless steel covering will not be accepted.
   3. All exposed nuts, bolts, fasteners, and hardware shall be of Type 316 stainless steel.

C. Mating Surface Seals:
   1. Where watertight sealing is required, shall be machined and be fitted with a double set of nitrile rubber or Viton O-rings.

D. Propeller:
   1. 316 Stainless Steel, dynamically balanced, non-clogging backward curved design
   2. Vanes of the diameter and blade angle as recommended by the manufacturer to provide the performance specified herein.
   3. Each blade shall be manufactured with quality control measures necessary to ensure that the propeller is properly balanced.
   4. Secured to the shaft by friction clutch to prevent damage to the propeller or shaft in the event an object becomes jammed in the propeller.
   5. Shaft shall be Type 316 stainless steel.

E. Bearings:
   1. Permanently lubricated bearings for shaft rotation.
   2. Outboard, propeller end, bearing is angular contact bearing.
   3. Inboard, motor end, bearings are angular contact to take up the axial loads and a radial bearing to take up the radial loads.
   4. Have a minimum L-10 rated life of 100,000 hours.
F. Shaft Seals
   1. Each mixer shall be provided with a multi-stage seal system to provide adequate protection of internal components during submerged operations.
   2. Seal system shall consist of double mechanical seals running in an oil chamber for cooling and lubrication with additional leap seals as necessary.
   3. Mechanical seals shall contain a stationary and positively driven rotating face ring made of silicon carbide and/or tungsten carbide.
   4. Seals shall require neither maintenance nor adjustment but shall be easy to check and replace.
   5. Only the seal faces of the outer seal assembly shall be exposed to the mixed media.
   6. All seal faces shall be capable of relapping.
   7. Each mixer shall be provided with an oil chamber for the shaft sealing system.
   8. Oil chamber shall be designed for oil pressure compensation.
   9. Drain and inspection plugs, with positive anti-leak seal, shall be easily accessible from the outside.

G. Drive Unit:
   1. The motor drive unit shall be gearbox or direct drive.
   2. Gear unit:
      a. Each mixer shall be provided with a two stage crossed (helical) cylindrical gear,
         1) High precision low-loaded gears designed for infinite life.
   3. Shafts shall rotate on bearings with a minimum L-10 rated life of 100,000 hours.

2.6 MOUNTING ASSEMBLY

A. Includes:
   1. Vertical support mast
   2. Mounting base plate
   3. Sliding bracket
   4. Fastening hardware

B. All components 316 stainless steel material

C. Vertical support mast:
   1. Designed to secure mixer in place during operation by providing adequate thrust resistance under all conditions.
   2. Supported from the basin floor and the basin walkway as shown on the Drawings
   3. Minimum of 2” by 2” by 3/16”.
   4. Permit horizontal and vertical changing of the mixer axis.
   5. Cable holder to prevent electrical cable entanglement.
   6. Constructed in conjunction with a lock pin at the upper guide hold to lock the mast in place under all operating conditions.

2.7 ACCESSORIES

A. Lifting Cable:
   1. Minimum 1/4-inch diameter stainless steel lifting cable
   2. Top of the cable shall end in an eye of sufficient strength to develop the strength of the cable
   3. Provide a hook to secure the cable at the top of the walkway

B. Lifting Lugs: Equipment weighing over 100 pounds shall be provided with lifting lugs.

C. Identification Plate:
1. 16-gauge stainless steel identification plate securely mounted on the equipment in a readily visible location.
2. Plate shall bear the 1/4-inch die-stamped equipment identification number and equipment data.

D. Anchors:
1. Concrete anchors in conformance with Division 05, METALS.
3. Coordinate required size and location with Shop Drawings.
4. The Contractor shall coordinate with the Manufacturer to source the anchoring system and provide a template for anchor bolt locations.

2.8 ELECTRICAL COMPONENTS AND ACCESSORIES

A. General:
1. Conform to Division 26, ELECTRICAL.
2. Provide all necessary electrical components and wiring for a complete, functional system.
3. Each mixer shall be supplied with a supervision relay that monitors for pump temperature overload and seal fail. Coordinate with motor control center manufacturer for installation of relay in motor control starter bucket.
4. Motor starters for submersible mixers are provided in a separate motor control center specified in Division 26, ELECTRICAL. Provide all necessary control functions to properly interface with this motor starter.

B. Wiring: The Drawings and Specifications indicate the anticipated wiring for the equipment provided under this section. If additional wiring is required, or if required wiring does not match what is indicated, the Contractor shall make the necessary modifications to the electrical wiring and documentation as part of the lump sum price. Wiring shall meet the requirements of Division 26, ELECTRICAL, and NFPA 70. Insulation shall be rated 600 volts, minimum. Low-voltage (24V) signals shall be run in twisted, shielded pair cable.

C. Electrical Raceways: Electrical wiring shall be installed in conduit meeting the requirements of Division 26, ELECTRICAL. Raceways shall be installed in accordance with Division 26, ELECTRICAL, and NFPA 70.

2.9 INSTRUMENTATION AND CONTROLS

A. All instrumentation and control components shall be provided in accordance with the requirements of Division 40, ELECTRICAL.

2.10 TOOLS AND SPARE PARTS

A. Tools: The work includes furnishing two complete set of special tools as recommended by the manufacturer for maintenance and repair of each separate type of equipment; tools shall be stored in tool boxes and identified with the equipment number by means of stainless steel or solid plastic name tags attached to the box.

B. Spare Parts:
1. All equipment shall be furnished with the specified manufacturers spare parts as indicated in the individual equipment sections.
2. Spare parts shall be tagged by project equipment number and identified as to part number, equipment manufacturer and subassembly component (if appropriate). Spare parts subject to deterioration such as ferrous metal items and electrical components shall be properly protected by lubricants or desiccants and encapsulated in hermetically sealed plastic wrapping. Spare parts with individual weights less than 50 pounds and dimensions less
than 2 feet wide or 18 inches high or 3 feet in length shall be stored in a wooden box with hinged wooden cover and locking clasp. Hinges shall be strap type. The box shall be painted and identified with stenciled lettering stating the name of the equipment, equipment numbers and the words “spare parts.” A neatly typed inventory of spare parts shall be taped to the underside of the cover. At a minimum, provide the following spare parts for each mixer:

a. One set motor shaft bearings.
b. One set seals, gaskets, and O-rings.
c. One set special tools (if required).

2.11 FABRICATION

A. Shop Assembly: The system shall be factory assembled and tested.

B. Shop/Factory Finishing: Shop prime coatings shall conform to the requirements of Section 09 96 00.01, HIGH-PERFORMANCE COATINGS.

PART 3 - EXECUTION

3.1 GENERAL

A. Coordination shall include space and structural requirements, clearances, utility connections, signals, outputs and features required by the manufacturer including safety interlocks.

3.2 ASSEMBLY AND PREPARATION FOR SHIPMENT

A. Each drive unit including motor shall be completely factory assembled, aligned and securely crated for shipment. Accessory equipment which cannot be shipped assembled to the unit, such as shafts, baseplates, impellers, spare parts and anchorage materials, shall be separately crated clearly marked as to the contents and shipped on the same shipment as the drives.

B. For shipment, exposed surfaces subject to rust such as mounting flange faces, etc., shall be covered with a rust-preventive compound such as Kendall No. 5, or equal.

3.3 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. Comply with Section 01 66 00.00, PRODUCT STORAGE AND HANDLING REQUIREMENTS.

B. Delivery of Materials: Products shall be delivered in original, unbroken packages, containers, or bundles bearing the name of the manufacturer.

C. Storage: Products shall be carefully stored in a manner that will prevent damage and in an area that is protected from the elements.

D. Protection of Equipment: Equipment shall be boxed, crated, or otherwise protected from damage and moisture during shipment, handling, and storage. Equipment shall be protected from exposure to corrosive fumes and shall be kept thoroughly dry at all times. Pumps, motors, drives, electrical equipment, and other equipment with anti-friction or sleeve bearings shall be stored in weathertight and heated storage facilities prior to installation. For extended storage periods, plastic equipment wrappers shall not be used to prevent accumulation of condensate in gears and bearings.
3.4 INSTALLATION

A. As shown on the Drawings. All anchors, bolts, and accessories shall be 316 stainless steel. The manufacture shall provide templates for anchor bolt locations.

B. Lubricants: Include oil and grease for initial operation.

3.5 FIELD QUALITY CONTROL

A. Functional Testing: Six-hour continuous operation. Various starts and stops shall be utilized to fully demonstrate functional requirements.

B. Testing: Products shall be field-tested for compliance with the indicated requirements.

C. Witnesses: The Company, Owner, and the Engineer (at the option of either) reserves the right to witness field tests.

3.6 MANUFACTURERS’ SERVICES

A. A manufacturer’s representative for the equipment specified herein shall be present at the job site for the minimum person-days listed for the services hereunder, travel time excluded:
   Installation, Startup, and Testing Services:
   1. 1 person day for installation assistance, inspection, and Certificate of Proper Installation.
   2. 1/2 person-day for functional and performance testing.
   3. Provide Qualifications of Manufacturer’s Representative.
   4. Training Services:
      a. 1 person-day of prestart classroom or jobsite training of Owner’s personnel.
      b. Training of Owner’s personnel shall be at such times and at such locations as required and approved by the Owner.

B. See Section 01 75 60, TESTING, TRAINING, AND FACILITY START-UP.

3.7 MANUFACTURER’S CERTIFICATES

A. Provide Manufacturer’s certificate(s). In accordance with Section 01 79 00, DEMONSTRATION AND TRAINING.

3.8 SUPPLEMENTS

A. The supplements listed below are a part of this Specification:
   44 42 46.1 DS – Submersible Mixers

END OF SECTION
### Section 44 42 46.1: SUBMERSIBLE MIXERS DATA SHEET

**PROJECT:** Western Area WWTP Phase 1 Expansion  
**OWNER:** City of Huntsville  
**EQUIPMENT NAME(S):** Submersible Mixer  
**EQUIPMENT TAG NUMBER(S):** 20MIX101, 20MIX201  
**CONTROL PANEL(S):** See on Drawings

<table>
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<tr>
<th>MANUFACTURERS</th>
<th>MODEL</th>
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<tr>
<td>Sulzer</td>
<td>XRW 2121</td>
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#### SERVICE CONDITIONS
- **Liquid Mixed:** MLSS  
- **Concentration:** 1,500 - 6,000 mg/L  
- **Liquid Temperature:** 40 – 80 °F  
- **Length/ Width:** See Drawings  
- **Depth:** See Drawings  
- **Configuration:** See Drawings

#### PERFORMANCE REQUIREMENTS
- **Influent Flow:** Max: 42,300 gpm  
- **Min: 10,500 gpm**  
- **Min Thrust:** 350 N

#### EQUIPMENT DESCRIPTION
- **Mixer Type:** Submersible  
- **Material:** 316 Stainless Steel  
- **Shaft:** 316 Stainless Steel  
- **Shaft Seal:** Mechanical  
- **Propeller Dia.:** Per Manufacturer  
- **Lubrication:** Non-toxic oil  
- **Material:** 316 Stainless Steel  
- **Bearing Life:** >100,000 hrs

#### MOTOR DATA
- **Type:** Squirrel Cage Induction  
- **Manufacturer:** For multiple units of the same type of equipment, furnish motors and accessories of a single manufacturer.  
- **Hazardous Location:** Furnish motors for hazardous (classified) locations that conform to UL 674 and have an applied UL listing marking.  
- **Motor Horsepower:** 5 (Max.)  
- **Voltage:** 460  
- **Phase:** 3  
- **Frequency:** 60 Hz  
- **Max. Motor Speed:** 1800 rpm  
- **Enclosure Type:** Submersible  
- **Mounting Type:** Horizontal  
- **Load Class:** Variable Torque  
- **Service Factor:** 1.0 x 1.10

Variable Speed Drive: See Division 26, ELECTRIC, Provide Inverter Duty Rated Motors.  
Winding: One or Two  
Seal fail and thermal protection embedded in winding for submersible motor.  
Service Factor: 1.0 x 1.10

Motor nameplate horsepower shall not be exceeded at any operational point.  
Additional Motor Requirements: See Section 26 05 15, ELECTRIC MOTORS  
Provide: Space Heater  
Oversize main terminal (conduit) box for motors.  
Moisture detection switches

#### SPECIAL FEATURES / NOTES
- Cable entry seal design shall provide watertight submersible seal.
SECTION 44 42 56.29 – WET-PIT SUBMERSIBLE PUMPS

PART 1 - GENERAL

1.1 SUMMARY

A. This section includes the Work necessary to complete furnish, install and place into operation the submersible pump(s) required to complete this project. This section includes submersible pump(s) to be supplied with motor, close coupled volute, cast iron discharge elbow, guide bar brackets, power cable and accessories as specified herein, and as further specified in the Submersible Pump Data Sheets hereinafter.

B. Related sections:
   1. Section 01 33 00 – Submittals.
   2. Section 01 66 00 – Product Storage and Handling Requirements.
   3. Section 01 78 23 – Operation and Maintenance Data.
   4. Section 01 79 00 – Electrical Demonstration and Training.
   5. Section 09 97 23 – Concrete or Masonry Coatings.

1.2 COSTS OF PRE-NEGOTIATED ITEMS

A. Owner has entered into a pre-negotiated cost agreement with the specified manufacturer for some items in this section of the specification. Refer to Attachment “A” BID FORM for more details. The pre-negotiated cost agreement and proposal from the specified manufacturer is provided as an attachment to this specification section. The Contractor shall carefully review the pre-negotiated proposal and scope of supply to determine those items required by the Contract Documents which are not part of the proposal or specified manufacturer’s scope of supply. In addition to the pre-negotiated costs indicated in Attachment “A” BID FORM, the Contractor shall include in the Lump Sum Bid Price the costs for the following:
   1. All items not specifically itemized in the manufacturer's scope of supply provided as part of the pre-negotiated proposal but required by the Contract Documents and/or necessary to provide a complete and operational system.
   2. All items specifically itemized in the manufacturer’s scope of supply provided as part of the pre-negotiated proposal which are designated to be provided by others, provided by the customer, provided by the Owner, or any similar designation.
   3. All labor, materials, and all other associated costs not included in the pre-negotiated proposal but required by the Contract Documents and required to provide a complete and operational system.

1.3 GENERAL

A. Like items of equipment provided hereunder shall be the end products of one Manufacturer in order to achieve standardization for appearance, operation, maintenance, spare parts, and Manufacturer's service.

B. Unit Responsibility: The Work requires the Submersible Pumps complete with all accessories and appurtenances (including, but not necessarily limited to, pump, motor, base elbow, guiderails, guiderail mount accessories, lift chains or cables, spare parts, start-up, testing, and personnel training) be the end product of one responsible Manufacturer. Unless otherwise indicated, the Contractor shall obtain each system from the Manufacturer of the equipment, which Manufacturer shall provide all components of the system to enhance compatibility, ease of construction, and efficient operation and maintenance, and as necessary to place the equipment in operation and its intended functions without altering or modifying the Contractor's responsibilities under the Contract Documents. The Contractor is responsible to the Owner for performance of all equipment systems as indicated.
C. General Requirements: See Division 01, GENERAL REQUIREMENTS, which contains information and requirements that apply to the work specified herein and are mandatory for this project.

1.4 SUBMITTALS

A. General: Administrative, shop drawings, samples, quality control, and contract closeout submittals shall conform to the requirements of Section 01 33 00, SUBMITTAL PROCEDURES.

B. In addition to the requirements of Section 01 33 00, SUBMITTAL PROCEDURES, submit the following additional specific information:

1. Shop Drawings: Shop drawings shall include descriptive information as required to fully describe the Pumps, Controls, Motors, and overall performance and shall identify any deviations from the specified requirements.

2. For pumps equipped with variable frequency drives. Provide a VFD analysis showing single pump operation, and parallel pump operation at increments not greater than 5 Hz between 60 Hz and 35 Hz or the minimum safe operating frequency, whichever is greater. Each increment shall include flow, head, and pump efficiency.

3. Special handling instructions, in accordance with Section 01 66 00, PRODUCT STORAGE AND HANDLING REQUIREMENTS.

4. Requirements for storage and protection prior to installation, in accordance with Section 01 66 00, PRODUCT STORAGE AND HANDLING REQUIREMENTS.

5. Motor information to be submitted in accordance with Division 26, ELECTRICAL.

6. Motor data information including:
   a. FLA
   b. LRA
   c. Power Factor (at least 3 load points between 0 – 100%)
   d. Efficiency throughout curve
   e. Insulation
   f. NEMA Design Code
   g. Service Factor
   h. VFD compatibility assurance
   i. Number of allowable starts per hour
   j. Conductor cut sheets
   k. Overvoltage/undervoltage recommendation settings of motor
   l. Overload recommendation setting

7. Quality control submittals as listed in Section 01 33 00, SUBMITTALS of Division 01, GENERAL REQUIREMENTS.


1.5 QUALITY CONTROL

A. The materials covered under these specifications are intended to be standard equipment of proven reliability and as manufactured by a reputable manufacturer having experience in the production of screening equipment. The equipment furnished shall be designed and constructed in accordance with the best practices and methods and shall operate satisfactorily when installed as shown on the Contract Drawings and operated per the manufacturer’s recommendations.

B. Fabrication shall be done in compliance with all applicable ASTM standards or equivalent international standards.

C. Balancing: Rotating elements of equipment, except small, commercially packaged equipment, shall be statically and dynamically balanced at the factory prior to final assembly. The Contractor shall furnish certified copies of all test results.
1.6 OPERATION AND MAINTENANCE DATA
   A. O&M Manuals: Content, format, and schedule for providing as specified in Section 01 78 23, OPERATION AND MAINTENANCE DATA.
   B. Maintenance Summary Forms: As specified in Section 01 78 23, OPERATION AND MAINTENANCE DATA.

1.7 WARRANTY
   A. Provide warranty for a period of 12 months from start-up and 18 months after the final acceptance of the equipment by the Owner and Engineer. The warranty shall stipulate that the equipment furnished is suitable for the purpose intended and free from defects of material and workmanship for the duration of the warranty. In the event the equipment fails to perform as specified, the Manufacturer will promptly repair or replace the defective equipment without additional cost to the Owner.
   B. Spare parts identified within this specification shall not be used to address warranty repairs.

PART 2 - PRODUCTS

2.1 MANUFACTURERS
   A. Where a manufacturer’s standard equipment name and/or model number is listed, the equipment system shall be provided and modified as required to conform to the performance, functions, features, and materials of construction as specified herein.
   B. Materials, equipment, and accessories specified in this section shall be products of:
      1. Sulzer.

2.2 GENERAL REQUIREMENTS
   A. Furnish and install submersible non-clog wastewater pump(s). Each pump shall be equipped with a submersible electric motor, connected for operation on 460 volts, 3 phase, 60 hertz, with 65 feet of submersible cable (SUBCAB) suitable for submersible pump applications. The power cable shall be sized according to NEC and ICEA standards. See supplement data sheets for specific pump information.
   B. The use of a Manufacturer’s name and model or catalog number is for the purpose of establishing the standard of quality and general configuration, but modifications shall be made to ensure all requirements specified herein are met. Specific pump models are suggested and other models meeting the service and duty requirements will be considered.

2.3 BEARINGS
   A. The integral pump/motor shaft shall rotate on two bearings. The motor bearings shall be sealed and permanently grease lubricated with high temperature grease. The upper motor bearing shall be a two row angular contact ball bearing. The lower bearing shall be a two row angular contact ball bearing to handle the thrust and radial forces. The minimum L10 bearing life shall be 50,000 hours at any usable portion of the pump curve.

2.4 MECHANICAL SEALS
   A. Each pump shall be provided with a positively driven dual, tandem mechanical shaft seal system consisting of two seal sets, each having an independent spring. The rotating seal ring
shall have small back-swept grooves laser inscribed upon its face to act as a pump as it rotates, returning any fluid that should enter the dry motor chamber back into the lubricant chamber. All seal rings shall be individual solid sintered rings. Each seal interface shall be held in place by its own spring system. The seals shall not depend upon direction of rotation for sealing. Mounting of the lower seal on the impeller hub is not acceptable. Shaft seals without positively driven rotating members or conventional double mechanical seals containing either a common single or double spring acting between the upper and lower seal faces are not acceptable. The seal springs shall be isolated from the pumped media to prevent materials from packing around them, limiting their performance.

B. Each pump shall be provided with a lubricant chamber for the shaft sealing system. The lubricant chamber shall be designed to prevent overfilling and shall provide capacity for lubricant expansion. The seal lubricant chamber shall have one drain and one inspection plug that are accessible from the exterior of the motor unit. The seal system shall not rely upon the pumped media for lubrication.

C. The area about the exterior of the lower mechanical seal in the cast iron housing shall have cast in an integral concentric spiral groove. This groove shall protect the seals by causing abrasive particulate entering the seal cavity to be forced out away from the seal due to centrifugal action.

D. A separate seal leakage chamber shall be provided so that any leakage that may occur past the upper, secondary mechanical seal will be captured prior to entry into the motor stator housing. Such seal leakage shall not contaminate the motor lower bearing. The leakage chamber shall be equipped with a float type switch that will signal if the chamber should reach 50% capacity.

2.5 ACCESSORIES

A. Discharge Base and Elbow:
   1. Materials: Same as pump casing.
   2. Features:
      a. Structurally capable of firmly supporting guide rails, discharge piping and pumping unit under operating conditions.
      b. One or more integral support legs or pads with provisions for bolting to sump floor.
      c. Incorporates 90-degree flanged elbow that receives horizontal flow from pump and discharges flow vertically.
   3. Discharge Interface:
      a. Sealing of the pumping unit to the discharge connection shall be accomplished by a machined metal to metal watertight contact or with a double set of nitrile rubber or Viton O-rings watertight contact.
      b. Self-aligning without having to enter the wet well.
      c. Discharge elbow to mate to pump discharge and transition to discharge piping.

B. Guide rails, brackets, fasteners, and lifting chain for each pump:
   1. Material: Type 316 stainless steel, with the following features:
      a. Dual pipes or dual rails that extend from discharge base to upper bracket unless scheduled otherwise.
      b. Rail wall thickness sufficient to suspend pump unit between brackets plus minimum 50 percent safety factor.
      c. Sized to fit discharge base and sliding bracket of pump.
      d. Integral, self-aligning, guide rail sliding brackets that seal pump to discharge base under operating conditions.
      e. Upper guide rail bracket.
      f. Intermediate guide rail brackets shall be where indicated on the Drawings or the minimum between 10-foot maximum intervals or as recommended by the pump manufacturer.
g. Lifting chain of sufficient strength and length to permit safe removal of pump unit from sump.

h. For setting greater than 15 feet, provide double harness rings in chain or cable every 15 feet and a hook to support pump and chain from concrete wall at ground surface.

2.6 PUMP ACCESSORIES

A. Equipment Identification Plate: A 16-gauge stainless steel identification plate shall be securely mounted on each pump in a readily visible location. The plate shall bear the 1/4" die-stamped equipment identification number name that is assigned to each pump in the Submersible Pump Data Sheets and shown on the Drawings.

B. Lifting Lugs/Handle: Equipment weighing over 100 pounds shall be provided with lifting lugs/handle.

C. Painting: Provide touch-up painting for post-installation.

D. See Submersible Pump Data Sheets following this Section.

E. Spare Parts and Special Tools (if required): See Submersible Pump Data Sheets for spare parts and special tools required for each pump or set of pumps.

2.7 MOTOR REQUIREMENTS

A. Motor shall be selected in accordance with the pump's non-overloading performance characteristics. Motor horsepower rating shall be chosen in keeping with the pump's possible peak horsepower requirements.

B. Each pump motor shall be sufficiently cooled by submergence in the pumped media or by an integral motor cooling system. Manufacturer shall determine if the internal cooling system is required for proper operation of the motor and furnish the system accordingly. See Submersible Pump Data Sheet(s). A stainless-steel cooling jacket shall encircle the stator housing, providing for dissipation of motor heat regardless of the type of pump installation. An impeller, integral to the cooling system and driven by the pump shaft, shall provide the necessary circulation of the cooling liquid through the jacket. The cooling liquid shall pass about the stator housing in the closed loop system in turbulent flow providing for superior heat transfer. The cooling system shall have one fill port and one drain port integral to the cooling jacket.

C. The cable entry seal design shall preclude specific torque requirements to insure a watertight and submersible seal. The cable entry shall consist of dual cylindrical elastomer grommets or Buna-N grommet, flanked by washers, all having a close tolerance fit against the cable outside diameter and the entry inside diameter. The grommets shall be compressed by the cable entry unit, thus providing a strain relief function. The assembly shall provide ease of changing the cable when necessary using the same entry seal. The cable entry junction chamber and motor shall be sealed from each other, which shall isolate the stator housing from foreign material gaining access through the pump top. Epoxies, silicones, or other secondary sealing systems shall not be considered equal.

D. The pump motor shall be a NEMA B design, induction type with a squirrel cage rotor, shell type design, housed in an air filled, watertight chamber. The stator windings shall be insulated with moisture resistant Class H insulation rated for 180°C (356°F). The stator shall be insulated by the trickle impregnation method using Class H monomer-free polyester resin resulting in a winding fill factor of at least 95%. The motor shall be inverter duty rated in accordance with NEMA MG1, Part 31. The stator shall be heat-shrink fitted into the cast iron stator housing. The
use of multiple step dip and bake-type stator insulation process is not acceptable. The use of pins, bolts, screws, or other fastening devices used to locate or hold the stator and that penetrate the stator housing are not acceptable. The motor shall be designed for continuous duty while handling pumped media of up to 40°C (104°F). The motor shall be capable of operating in dry or partially submerged conditions for extended periods without damage. The motor shall be capable of no less than 30 evenly spaced starts per hour. The rotor bars and short circuit rings shall be made of aluminum. Three thermal switches shall be embedded in the stator end coils, one per phase winding, to monitor the stator temperature. These thermal switches shall be used in conjunction with and supplemental to external motor overload protection and shall be connected to the motor control panel.

E. The junction chamber shall be sealed off from the stator housing and shall contain a terminal board for connection of power and pilot sensor cables using threaded compression type terminals. The use of wire nuts or crimp-type connectors is not acceptable. The motor and the pump shall be produced by the same manufacturer.

F. The motor service factor (combined effect of voltage, frequency, and specific gravity) shall be 1.15. The motor shall have a voltage tolerance of ±10%. The motor shall be designed for continuous operation in up to an ambient temperature of 40°C ambient and shall have a NEMA Class B maximum operating temperature rise of 80°C. A motor performance chart shall be provided upon request exhibiting curves for motor torque, current, power factor, input/output kW and efficiency. The chart shall also include data on motor starting and no-load characteristics.

G. The motor and cable shall be capable of continuous submergence underwater without loss of watertight integrity to a depth of 65 feet or greater.

H. Motor shall also meet requirements specified in the following supplemental data sheet(s).

2.8 PROTECTION

A. Each pump motor stator shall incorporate three thermal switches, one per stator phase winding and be connected in series, to monitor the temperature of the motor. Should the thermal switches open, the motor shall stop and activate an alarm. A float switch shall be installed in the seal leakage chamber and will activate if leakage into the chamber reaches 50% chamber capacity, signaling the need to schedule an inspection.

B. The thermal switches and float switch shall be connected to a status monitoring unit. The unit shall be designed to be mounted in the pump control panel.

2.9 ELECTRICAL AND CONTROL SYSTEMS

A. Electrical products and execution required to complete the Work under this section shall conform to the applicable requirements of Division 26, ELECTRICAL.

B. Labeling: All electrical materials, devices, appliances, and equipment used shall be indicated as acceptable by established standards. Indication shall be by a valid label affixed to the item. Panels that consist of multiple components shall be listed and labeled as a unit in addition to any other requirements.

C. Wiring: The Drawings and Specifications indicate the anticipated wiring for the equipment provided under this section. If additional wiring is required, or if required wiring does not match what is indicated, the Contractor shall make the necessary modifications to the electrical wiring and documentation as part of the lump sum price. Wiring shall meet the requirements of Division 26, ELECTRICAL, and NFPA 70. Insulation shall be rated 600 volts, minimum. Low-voltage (24V) signals shall be run in twisted, shielded pair cable.
D. Electrical Raceways: Electrical wiring shall be installed in conduit meeting the requirements of Division 26, ELECTRICAL. Raceways shall be installed in accordance with Division 26, ELECTRICAL, and NFPA 70.

2.10 INSTRUMENTATION AND CONTROLS

A. All instrumentation and control components shall be provided in accordance with the requirements of Division 40, ELECTRICAL.

2.11 FABRICATION

A. Shop prime and field finish paint ferrous metal in accordance with and as specified in Section 09 96 00, PAINTING AND PROTECTIVE COATINGS.

PART 3 - EXECUTION

3.1 GENERAL

A. Coordination shall include space and structural requirements, clearances, utility connections, signals, outputs, and features required by the manufacturer including safety interlocks.

3.2 ASSEMBLY AND PREPARATION FOR SHIPMENT

A. Each pump unit, including motor, shall be completely factory assembled, aligned, and securely crated for shipment. Accessory equipment which cannot be shipped assembled to the unit, such as shafts, baseplates, impellers, spare parts, and anchorage materials, shall be separately crated, clearly marked as to the contents, and shipped on the same shipment as the drives.

B. For shipment, exposed surfaces subject to rust, such as mounting flange faces, etc., shall be covered with a rust-preventive compound such as Kendall No. 5, or equal.

3.3 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. Comply with Section 01 60 00, PRODUCT REQUIREMENTS.

B. Delivery of Materials: Products shall be delivered in original, unbroken packages, containers, or bundles bearing the name of the manufacturer.

C. Storage: Products shall be carefully stored in a manner that will prevent damage and in an area that is protected from the elements.

3.4 FACTORY TESTS

A. Motor Tests and Test Reports: As specified in Division 26, ELECTRICAL.

B. Each pump and motor shall be performance tested at the factory. All pumps shall be tested with motor cables to be supplied with the pumps. Three copies of certified test reports, including actual test records, shall be submitted and approved by Engineer prior to shipment of the equipment.

C. Each pump shall be tested for performance at the factory to determine the head vs. capacity, and motor input power for the full speed at which the pumps are specified and shown on a certified performance test curve as continuous functions throughout the pump’s performance range. Tests of models, prototypes or similar units will not be acceptable. All tests shall be run in accordance with the test code for centrifugal pumps of the Standards of Hydraulic Institute,
latest edition, per Section 1.2.D.3. The motor and cable on each pump shall be tested for moisture content or insulation defects. After the test, the pump cable end shall be fitted with a shrink-fit rubber boot to protect it from moisture or water.

3.5 FIELD TESTS

A. Functional Test: Prior to startup, all equipment described herein and in the Submersible Pump Data Sheets following shall be inspected for proper alignment, quiet operation, proper connection, and satisfactory performance by means of a functional test. Provide certification of test results. Tests and certification shall be as specified in Section 01 78 23, OPERATION AND MAINTENANCE DATA.

B. Vibration Test: The complete assembly, consisting of the driving unit and pump, connected and in normal operation, shall not develop amplitudes of vibration exceeding limits recommended by the current edition of Hydraulic Institute Standards. If directed by Engineer, vibration tests shall be conducted at Contractor’s sole expense to determine amplitude of vibration, and Contractor shall make any corrections necessary to meet these requirements. If corrections are made, a second vibration test shall be done following corrections.

3.6 MANUFACTURER’S SERVICES

A. A manufacturer’s representative for the equipment specified herein shall be present at the job site for the minimum person-days listed for the services hereinunder, travel time excluded:

1. Installation, Startup, and Testing Services:
   a. 2 person-days for installation assistance, inspection, and Certificate of Proper Installation.
   b. 1 person-day for functional and performance testing.
   c. Provide Qualifications of Manufacturer’s Representative.

2. Training Services:
   a. 1 person-day of prestart classroom or jobsite training of Owner’s personnel.
   b. Training of Owner’s personnel shall be at such times and at such locations as required and approved by the Owner.

B. See Section 01 79 00, DEMONSTRATION & TRAINING of Division 01, GENERAL REQUIREMENTS.

3.7 MANUFACTURER’S CERTIFICATE(S)

A. Provide Manufacturer’s certificate(s). In accordance with Section 01 79 00, DEMONSTRATION AND TRAINING.

3.8 SUPPLEMENTS

A. The supplements listed below and following “END OF SECTION” are part of this Specification.

1. Section 44 42 56.29.1 – Return Activated Sludge Submersible Pump Data Sheet.
2. Section 44 42 56.29.2 – Waste Activated Sludge Submersible Pump Data Sheet.

END OF SECTION
### Project Information

**PROJECT:** Western Area WWTP Expansion Phase 1  
**OWNER:** Huntsville  
**EQUIPMENT NAME(S):** Return Activated Sludge Pumps  
**EQUIPMENT TAG NUMBER(S):** 50P102, 50P103, 50P202, 50P203  
**CONTROL PANEL(S):** See on Drawings  
**TOTAL PUMPS REQUIRED:** (3) Duty + (1) Standby

### MANUFACTURERS

| SULZER | XFP 305J-CB2 60HZ |

### SERVICE CONDITIONS

| Specific Gravity at 60 deg F: 0.99 – 1.10 | Capacity (US gpm): Rated: 4880 |
| Largest dia. Solid pump shall be capable of passing: 2 inch | Total Dynamic Head (ft): Single Pump Operational Range (with VFD): 20-46 |
| Min. NPSH available: 33.0 ft | Total Dynamic Head (ft) Rated: 42 |
| Explosion Proof (Y/N) Y | Maximum Shutoff Pressure (ft): 70 |
| Pumping Temperature (°F) 40 – 100 °F | Min. rated pump hydraulic efficiency at rated capacity (%): 75 |
| Max pump speed at rated capacity 1200 rpm | Minimum efficiency for operational range (%): 60 |

### PERFORMANCE REQUIREMENTS

| Casing Material: Cast Iron, A48 Class 35B | Minimum discharge port: 10” (inch) |
| Casing Wear Ring Material: Cast Iron, A48 Class 35B or Hard Iron, A 532 ALLOY III A (25% Chrome) | Guide Rail Material: Double, SST |
| Impeller Type: Balanced, semi-open or closed, multi-vane, Non-Clogging | Lifting Chain Material: 316 SST |
| Impeller Wear Ring (Y/N): N | Shaft Material: 420 or 431 Stainless Steel |
| Material: N/A | Double Mechanical Seal (Y/N): Y |

### EQUIPMENT DESCRIPTION

**Type:** Squirrel-cage induction meeting requirements of NEMA MG1.  
**Manufacturer:** For multiple units of the same type of equipment, furnish motors and accessories of a single manufacturer.  
**Hazardous Location:** Furnish motors for hazardous (classified) locations that conform to UL 674 and have an applied UL listing marking  
**Motor Horsepower:** 75 Maximum  
**Voltage:** 460  
**Phase:** 3  
**Frequency:** 60 Hz  
**Synchronous Speed:** 1200 rpm max  
**Service Factor:** 1.0  

### MOTOR DATA

- **Variable Speed Drive:** See Division 26, ELECTRIC. Provide Inverter Duty Rated Motors.  
- **Windings:** One Two  
- **Thermal protection embedded in windings:**  
- **Motor nameplate horsepower shall not be exceeded at any operational point:**  
  - Provide Space Heater  
  - Oversize main terminal (conduit) box for motors  
  - Moisture detection switches.

### SPECIAL FEATURES / NOTES

See Division 40 for general instrumentation and control requirements.  
Provide one pump repair kit for each pump type and special tools needed to dismantle pumps.
## Project Information

**Project:** Western Area WWTP Expansion Phase 1  
**Owner:** Huntsville  
**Equipment Name:** Waste Activated Sludge Pumps  
**Equipment Tag Number:** 50P101, 50P201  
**Control Panel:** See on Drawings  
**Total Pumps Required:** (1) Duty + (1) Standby

### Manufacturer

<table>
<thead>
<tr>
<th>Manufacturer</th>
<th>Suggested Model</th>
</tr>
</thead>
<tbody>
<tr>
<td>SULZER</td>
<td>XFP150G CB1 60HZ</td>
</tr>
</tbody>
</table>

### Service Conditions

<table>
<thead>
<tr>
<th>Service Conditions</th>
<th>Performance Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>Liquid Pumped</td>
<td>Waste Activated Sludge</td>
</tr>
<tr>
<td>Capacity (US gpm)</td>
<td>Single Pump Operational</td>
</tr>
<tr>
<td>Range (with VFD)</td>
<td>300-1400</td>
</tr>
<tr>
<td>Specific Gravity at 60 deg F</td>
<td>0.99 – 1.10</td>
</tr>
<tr>
<td>Largest Dia. Solid Pump shall be capable of passing</td>
<td>2 inch</td>
</tr>
<tr>
<td>Min. NPSH available</td>
<td>Flooded</td>
</tr>
<tr>
<td>Explosion Proof (Y/N)</td>
<td>Y</td>
</tr>
<tr>
<td>Pumping Temperature (°F)</td>
<td>40 – 100 °F</td>
</tr>
<tr>
<td>Max pump speed at rated capacity</td>
<td>1800 rpm</td>
</tr>
</tbody>
</table>

### Equipment Description

| Casing Material | Cast Iron, A48 Class 35B |
| Casing Wear Ring Material | Cast Iron, A48 Class 35B or Hard Iron, A 532 ALLOY III A (25% Chrome) |
| Impeller Type | Balanced, open, semi-open or closed, multi vane or single vane, Non-Clogging |
| Impeller Material | Cast Iron, A48 Class 35B or Hard Iron, A 532 ALLOY III A (25% Chrome) |
| Impeller Wear Ring (Y/N) | N |
| Material | N/A |
| Lifting Chain Material | 316 SST |
| Guide Rail Material | Double, SST |
| Pump Removal Hoist (Y/N) | Y |
| Shaft Material | Stainless Steel |

### Motor Data

| Type | Squirrel-cage induction meeting requirements of NEMA MG1. |
| Manufacturer | For multiple units of the same type of equipment, furnish motors and accessories of a single manufacturer. |
| Hazardous Location | ✗ Furnish motors for hazardous (classified) locations that conform to UL 674 and have an applied UL listing marking |
| Motor Horsepower | 20 Maximum |
| Voltage | 460 |
| Phase | 3 |
| Frequency | 60 Hz |
| Synchronous Speed | 1800 rpm max |
| Service Factor | 1.0 1.15 |
| Variable Speed Drive | See Division 26, ELECTRIC. Provide Inverter Duty Rated Motors. |
| Windings | One Two |
| Thermal protection embedded in windings | ✗ |
| Motor nameplate horsepower shall not be exceeded at any operational point. | |
| Provide | Space Heater Oversize main terminal (conduit) box for motors |
| Moisture detection switches | ✗ |

### Special Features / Notes

- See Division 26 for general instrumentation and control requirements.
- Provide one pump repair kit for each pump type and special tools needed to dismantle pumps.
SECTION 44 42 56.39 SUBMERSIBLE CHOPPER PUMPS

PART 1 - GENERAL

1.1 SUMMARY

A. This section includes the Work necessary to completely furnish and install the submersible chopper pumps including all related equipment, material, and appurtenances as shown on the drawings and specified herein.

B. Related Sections:
   1. Section 01 33 00 – Submittal Procedures.
   2. Section 01 60 00 – Product Requirements.
   3. Section 01 78 23 – Operation and Maintenance Data.
   4. Section 01 79 00 – Demonstration and Training.
   5. Section 05 50 00 – Metal Fabrications.
   6. Division 26 – Electrical.

1.2 COSTS OF PRE-NEGOTIATED ITEMS

A. Owner has entered into a pre-negotiated cost agreement with the specified manufacturer for some items in this section of the specification. Refer to Attachment “A” BID FORM for more details. The pre-negotiated cost agreement and proposal from the specified manufacturer is provided as an attachment to this specification section. The Contractor shall carefully review the pre-negotiated proposal and scope of supply to determine those items required by the Contract Documents which are not part of the proposal or specified manufacturer's scope of supply. In addition to the pre-negotiated costs indicated in Attachment “A” BID FORM, the Contractor shall include in the Lump Sum Bid Price the costs for the following:
   1. All items not specifically itemized in the manufacturer’s scope of supply provided as part of the pre-negotiated proposal but required by the Contract Documents and/or necessary to provide a complete and operational system.
   2. All items specifically itemized in the manufacturer’s scope of supply provided as part of the pre-negotiated proposal which are designated to be provided by others, provided by the customer, provided by the Owner, or any similar designation.
   3. All labor, materials, and all other associated costs not included in the pre-negotiated proposal but required by the Contract Documents and required to provide a complete and operational system.

1.3 GENERAL

A. Equipment Numbers: See supplemental data sheet at end of section.

B. Like items of equipment provided hereinafter shall be the end products of one manufacturer to achieve standardization of appearance, operation, maintenance, spare parts and manufacturer's services.

C. Unit Responsibility: The Work requires that the pumps, and components complete with all accessories and appurtenances be the end product of one responsible system manufacturer or responsible system supplier. Unless otherwise indicated, the Contractor shall obtain each system from the responsible supplier of the equipment, which supplier shall furnish all components and accessories of the system to enhance compatibility, ease of operation and maintenance, and as necessary to place the equipment in operation in conformance with the specified performance, features, and functions without altering or modifying the Contractor's responsibilities under the Contract Documents. The Contractor shall obtain the Davit Cranes
from the crane manufacturer as required in Section 41 22 17. The Contractor is responsible to the Owner for providing the equipment systems as specified herein.

D. General Requirements: See Division 01, GENERAL REQUIREMENTS, which contains information and requirements that apply to the work specified herein and are mandatory for this project.

E. The equipment specified herein is included in the MANUFACTURER/ SUBCONTRACTOR Form. Refer to the Bid Form and the Instructions to Bidders for additional requirements.

1.4 SUBMITTALS

A. General: Administrative, shop drawings, samples, quality control, and contract closeout submittals shall conform to the requirements of Section 01 33 00, SUBMITTAL PROCEDURES.

B. In addition to the requirements of Section 01 33 00, SUBMITTAL PROCEDURES, submit the following additional specific information:

1. Shop Drawings:
   a. Make, model, weight, and horsepower of each component.
   b. Manufacturer's catalog information, descriptive literature, specifications, and identification of materials of construction.
   c. Detailed mechanical, and electrical drawings showing the equipment fabrications and interface with other items. Include dimensions, size, and details of anchorage and of connections to other work, and weights of associated equipment.
   d. Pump curve showing specified performance point.
   e. External utility requirements (quantity and connection details) such as air, water, power, drain etc., for each component.
   f. Motor nameplate data, motor manufacturer, and any motor modifications.
   g. Wiring diagrams for motors, including terminals and numbers.
   h. Suggested spare parts list to maintain the equipment in service for a period of 1 year and 5 years. Include a list of special tools required for checking, testing, parts replacement, and maintenance with current price information.
   i. List of special tools, materials, and supplies furnished with equipment for use prior to and during startup and for future maintenance.
   j. Instrumentation and Control Submittals: In conformance with Division 26.

2. Quality Control Submittals:
   a. Manufacturer's Certificate of Compliance: Commercial products, including painting/coating systems.
   b. Special shipping, storage and protection, and handling instructions.
   c. Test procedures.
   d. Test results, reports, and certifications.
   e. Manufacturer's Certificate of Proper Installation.
   f. Operation and maintenance manual.


1.5 QUALITY CONTROL

A. Balancing: Rotating elements of equipment, except small, commercially packaged equipment, shall be statically and dynamically balanced at the factory prior to final assembly. The Contractor shall furnish certified copies of all test results.
1.6 OPERATION AND MAINTENANCE DATA
   
   A. O&M Manuals: Content, form, and schedule for providing as specified in Section 01 78 23, OPERATION AND MAINTENANCE DATA.

   B. Maintenance Summary Forms: As specified in Section 01 78 23, OPERATION AND MAINTENANCE DATA.

1.7 WARRANTY
   
   A. Provide warranty for a period of 12 months after the final acceptance of the equipment by the Owner and Engineer. The warranty shall stipulate that the equipment furnished is suitable for the purpose intended and free from defects of material and workmanship for the duration of the warranty. In the event the equipment fails to perform as specified, the Manufacturer will promptly repair or replace the defective equipment without additional cost to the Owner.

   B. Spare parts identified within this specification shall not be used to address warranty repairs.

PART 2 - PRODUCTS

2.1 MANUFACTURERS
   
   A. Where a manufacturer's standard equipment name and/or model number is listed, the equipment system shall be provided and modified as required to conform to the performance, functions, features, and materials of construction as specified herein.

   B. Materials, equipment, components, and accessories specified in this section shall be, products of:
      1. Tsurumi.

2.2 GENERAL REQUIREMENTS
   
   A. Noise Level: When in operation, no piece of equipment shall exceed the OSHA noise level requirements for a 1-hour exposure, 105 dBA.

   B. Service Factors: Service factors shall be applied in the selection and design of components where so indicated in individual sections. When not indicated there, minimum service factors shall be 1.0.

   C. Safety Devices: The completed work shall include all necessary permanent safety devices, such as machinery guards, emergency stops and similar items required by OSHA, and other federal, state, and local health and safety regulations.

   D. Flanges and Pipe Threads: Comply with ANSI B 16.1, Class 125; or B 16.5, Class 150, unless otherwise indicated. Threaded flanges and fittings shall have standard taper pipe threads complying with ANSI/ASME B 1.20.1.

   E. Anchor bolts shall be specified in Section 05 50 00, METAL FABRICATIONS. Number and size as recommended by manufacturer.

   F. Stainless Steel: Stainless steel components shall be 304 stainless steel, or higher, as specified.

   G. Nameplates: Equipment nameplates of stainless steel shall be engraved or stamped and fastened to the equipment in accessible locations with stainless steel screws or drive pins.
Nameplates shall contain the manufacturer's name, model, serial number, size, characteristics, and appropriate data describing the machine performance ratings.

H. Lifting Lugs/Handle: Equipment weighing over 100 pounds shall be provided with lifting lugs/handle.

I. Painting: Provide touch-up painting for post-installation to be supplied by the contractor.

2.3 SUPPLEMENTS

A. See supplements to this section for additional equipment system product, component, or accessory information.

2.4 SERVICE CONDITIONS

A. The pump(s) shall be heavy duty, electric submersible, centrifugal chopper type units designed for handling raw, unscreened sewage and wastewater and shall be fully guaranteed for this use.

B. The pump, mechanical seals and motor units provided under this specification shall be provided by the same manufacturer in order to achieve standardization of operation, maintenance, spare parts, manufacturer's service and warranty.

2.5 EQUIPMENT AND/OR MATERIALS

A. Pump and Motor Casing:
   1. Type: Water tight, air filled.
   3. Water-tightness: Able to run submerged up to 50 feet.
   4. Design Working Pressure: Minimum 1.10 times maximum shutoff total dynamic head with maximum diameter impeller at maximum operating speed plus maximum suction static head or minimum 20 pounds per square inch gauge.
   5. O-ring Seals: Capable of sealing mated surfaces (major components) watertight with the following features.
      a. Machined surfaces and grooves.
      b. O-ring contact on four surfaces and O-ring compression on 2 surfaces.
      c. Does not require specific fastener torque or tension to obtain watertight joint.
      d. Does not require secondary sealing compounds, gasket, grease, or other devices.
   6. All exposed nuts and bolts shall be 316 stainless steel.

B. Impellers:
   1. Type: Impellers shall be open or semi open multi vane cutting impellers with a single volute casing for liquids containing long fibers and large solids.
   3. Casting: One piece, free of cracks and porosity.
   4. Balance: Statically and dynamically balanced at the factory prior to final assembly.

C. Cutting Bars:
   1. Material: ASTM A532, Type II or III abrasion resistant white-alloyed iron or cast steel heat treated to Rockwell C60.

D. Bearings:
   1. Except where otherwise indicated, bearings of process equipment shall have a minimum L10 life expectancy of 50,000 hours.

E. Shaft Seals:
1. Upper Seal Unit Material: One stationary carbon ring and one positively driven rotating carbon ring, or a carbon rotating face and a ceramic stationary face.
2. Lower Seal Unit Material: One stationary and one positively driven rotating tungsten-carbide ring.
3. Features:
   a. Tandem arrangement running in an oil chamber.
   b. Design oil chamber to assure that air is left in the oil chamber to absorb the expansion of the oil due to temperature variations.
   c. Independent spring system between seal interfaces able to withstand maximum suction submergences.
   d. Does not require pressure differential to affect sealing.
   e. Does not use pumped media for lubrication.
   f. Lower mechanical seal effectively lubricated from oil chamber housings.
   g. Springs and Other Hardware: Stainless steel, 300 or 400 series.
4. Moisture sensing system: Intrinsically safe type that signals seal leakage.
5. Provide oil chamber with manufacturer’s standard drain and inspection plug, with positive anti-leak seal, easily accessible from the outside.

F. Discharge Base and Elbow:
1. Materials: Same as pump casing.
2. Features:
   a. Structurally capable of firmly supporting guide rails, discharge piping and pumping unit under operating conditions.
   b. One or more integral support legs or pads with provisions for bolting to sump floor.
   c. Incorporates 90 degree flanged elbow that receives horizontal flow from pump and discharges flow vertically.
3. Discharge Interface:
   a. Sealing of the pumping unit to the discharge connection shall be accomplished by a machined metal to metal watertight contact.
   b. Self-aligning without having to enter the wet well.
   c. Discharge elbow to mate to pump discharge and transition to discharge piping.

G. Guide rails, brackets, fasteners, and lifting chain for each pump:
1. Material: Type 316 stainless steel, with the following features:
   a. Dual pipes or dual rails that extend from discharge base to upper bracket unless scheduled otherwise.
   b. Rail wall thickness sufficient to suspend pump unit between brackets plus minimum 50 percent safety factor.
   c. Sized to fit discharge base and sliding bracket of pump.
   d. Integral, self-aligning, guide rail sliding brackets that seal pump to discharge base under operating conditions.
   e. Upper guide rail bracket.
   f. Intermediate guide rail brackets where indicated on the Drawings or at 10-foot maximum intervals.
   g. Lifting chain of sufficient strength and length to permit safe removal of pump unit from sump should be supplied by the Davit crane supplier.
   h. For setting greater than 15 feet, provide double harness rings in chain or cable every 15 feet and a hook to support pump and chain from concrete wall at ground surface.

2.6 ELECTRICAL COMPONENTS AND ACCESSORIES

A. General:
1. Conform to Division 26, ELECTRICAL.
2. Provide all necessary electrical components and wiring for a complete, functional system.
3. Where indicated, motor starters shall be provided in a separate motor control center specified in Division 26, ELECTRICAL. Provide all necessary control functions to properly interface with this motor starter.

B. Wiring: The Drawings and Specifications indicate the anticipated wiring for the equipment provided under this section. If additional wiring is required, or if required wiring does not match what is indicated, the Contractor shall make the necessary modifications to the electrical wiring and documentation as part of the lump sum price. Wiring shall meet the requirements of Division 26, ELECTRICAL, and NFPA 70. Insulation shall be rated 600 volts, minimum. Low-voltage (24V) signals shall be run in twisted, shielded pair cable.

C. Electrical Raceways: Electrical wiring shall be installed in conduit meeting the requirements of Division 26, ELECTRICAL. Raceways shall be installed in accordance with Division 26, ELECTRICAL, and NFPA 70.

D. Motors:
1. Provide squirrel-cage ac induction motors meeting the requirements of Division 26, ELECTRICAL, and as specified herein.
2. For additional specific requirements on motors, refer to the Motor Data Sheets at the end of the Section.

2.7 PROTECTION
A. Each pump motor stator shall incorporate three thermal switches, one per stator phase winding and be connected in series, to monitor the temperature of the motor. Should the thermal switches open, the motor shall stop and activate an alarm. Moisture probes shall be installed in the seal leakage chamber and will signal the need to schedule an inspection.

B. A moisture relay shall be provided to be installed into the MCC to receive an alarm signal from the moisture probes.

2.8 INSTRUMENTATION AND CONTROLS
A. All instrumentation and control components shall be provided by the Electrical Contractor in accordance with the requirements of Division 40.

2.9 TOOLS AND SPARE PARTS
A. Tools: The work includes one complete set of special tools recommended by the manufacturer for maintenance and repair of each separate type of equipment; tools shall be stored in toolboxes, and identified with the equipment number by means of stainless steel or solid plastic name tags attached to the box.

B. Spare Parts:
1. Spare parts shall be tagged by project equipment number and identified as to part number, equipment manufacturer, and subassembly component (if appropriate). Spare parts subject to deterioration such as ferrous metal items and electrical components shall be properly protected by lubricants or desiccants and encapsulated in hermetically sealed plastic wrapping. Spare parts with individual weights less than 50 pounds and dimensions less than 2 feet wide, or 18 inches high, or 3 feet in length shall be stored in a wooden box with hinged wooden cover and locking clasp. Hinges shall be strap type. The box shall be painted and identified with stenciled lettering stating the name of the equipment, equipment numbers, and the words "spare parts." A neatly typed inventory of spare parts shall be taped to the underside of the cover.
2. Spare Parts and Special Tools (if required): See supplemental data sheets for spare parts and special tools required for each pump or set of pumps.

2.10 FINISHES

A. Factory Applied Finishes: Prepare surfaces and apply protective finishes as specified in Section 01 60 00, PRODUCT REQUIREMENTS.

B. Field Applied Finishes: Conform to the requirements of Section 09 90 00, PAINTING AND PROTECTIVE COATINGS.

PART 3 - EXECUTION

3.1 GENERAL

A. Coordination shall include space and structural requirements, clearances, utility connections, signals, outputs, and features required by the manufacturer including safety interlocks.

3.2 ASSEMBLY AND PREPARATION FOR SHIPMENT

A. Each drive unit, including motor, shall be completely factory assembled, aligned, and securely crated for shipment. Accessory equipment which cannot be shipped assembled to the unit, such as shafts, baseplates, impellers, spare parts, and anchorage materials, shall be separately crated, clearly marked as to the contents, and shipped on the same shipment as the drives.

B. For shipment, exposed surfaces subject to rust, such as mounting flange faces, etc., shall be covered with a rust-preventive compound such as Kendall No. 5, or equal.

3.3 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. Comply with Section 01 60 00, PRODUCT REQUIREMENTS.

B. Delivery of Materials: Products shall be delivered in original, unbroken packages, containers, or bundles bearing the name of the manufacturer.

C. Storage: Products shall be carefully stored in a manner that will prevent damage and in an area that is protected from the elements.

D. Protection of Equipment: Equipment shall be boxed, crated, or otherwise protected from damage and moisture during shipment, handling, and storage. Equipment shall be protected from exposure to corrosive fumes and shall be kept thoroughly dry at all times. Pumps, motors, drives, electrical equipment, and other equipment with anti-friction or sleeve bearings shall be stored in weather-tight and heated storage facilities prior to installation. For extended storage periods, plastic equipment wrappers shall not be used to prevent accumulation of condensate in gears and bearings.

3.4 FIELD QUALITY CONTROL

A. Functional Test: Prior to plant startup, all equipment described herein and in the submersible pump data sheets following shall be inspected for proper alignment, quiet operation, proper connection, and satisfactory performance by means of a functional test. Provide certification of test results. Tests and certification shall be as specified in Section 01 79 00 DEMONSTRATION AND TRAINING.
3.5 INSTALLATION
A. Install in strict accordance with contract drawings and manufacturer’s directions and recommendations.
B. Lubricants: Include oil and grease for initial operation.

3.6 MANUFACTURER’S SERVICES
A. A manufacturer’s representative for the equipment specified herein shall be present at the job site for the minimum person-days listed for the services hereinunder, travel time excluded:
   1. Installation, Startup, and Testing Services:
      a. 1 person-day for installation assistance, inspection, and Certificate of Proper Installation.
      b. 1 person-day for functional and performance testing.
      c. Provide Qualifications of Manufacturer’s Representative.
   2. Training Services:
      a. 1 person-day of prestart classroom or jobsite training of Owner’s personnel.
      b. Training of Owner’s personnel shall be at such times and at such locations as required and approved by the Owner.
B. See Section 01 79 00, DEMONSTRATION & TRAINING.

3.7 MANUFACTURER’S CERTIFICATES
A. Provide Manufacturer’s certificate(s) in accordance with Section 01 79 00, DEMONSTRATION & TRAINING.

3.8 SUPPLEMENTS
A. The supplements listed below and following end of section are part of this Specification:
   1. Section 44 42 56.39.1 – Final Clarifier Scum Pump(s) Data Sheet.

END OF SECTION
# Section 44 42 56.29.3 – Final Clarifier Scum Wet-Pit Submersible Pumps Data Sheet

| PROJECT: | Western Area WWTP Expansion Phase 1 |
| OWNER: | Huntsville |
| EQUIPMENT NAME(S): | Scum Pumps |
| EQUIPMENT TAG NUMBER(S): | 40P502, 40P503 |
| CONTROL PANEL(S): | See on Drawings |
| TOTAL PUMPS REQUIRED: | (1) Duty + (1) Standby |

## MANUFACTURERS

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<tr>
<th>MANUFACTURERS</th>
<th>SUGGESTED MODEL</th>
</tr>
</thead>
<tbody>
<tr>
<td>TSURIMI</td>
<td>TOS3-80C41.5-CR-63</td>
</tr>
</tbody>
</table>

## SERVICE CONDITIONS

### PERFORMANCE REQUIREMENTS

<table>
<thead>
<tr>
<th>Liquid Pumped:</th>
<th>FINAL CLARIFIER SCUM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Capacity (US gpm): Single Pump Operational Range (with VFD):</td>
<td>N/A</td>
</tr>
<tr>
<td>Specific Gravity at 60 deg F:</td>
<td>0.99 – 1.10</td>
</tr>
<tr>
<td>Largest dia. Solid pump shall be capable of passing:</td>
<td>1.25 inch</td>
</tr>
<tr>
<td>Min. NPSH available:</td>
<td>Flooded</td>
</tr>
<tr>
<td>Explosion Proof (Y/N):</td>
<td>Y</td>
</tr>
<tr>
<td>Maximum Shutoff Pressure (ft):</td>
<td>N/A</td>
</tr>
<tr>
<td>Pumping Temperature (°F):</td>
<td>40 – 100 °F</td>
</tr>
<tr>
<td>Max pump speed at rated capacity:</td>
<td>1800 rpm</td>
</tr>
</tbody>
</table>

## EQUIPMENT DESCRIPTION

| Casing Material: | Cast Iron, A48 Class 35B |
| Casing Wear Ring Material: | Cast Iron, A48 Class 35B or Hard Iron, A 532 ALLOY III A (25% Chrome) |
| Impeller Type: | Balanced, open, semi-open or closed, multi vane or single vane, Non-Clogging |
| Impeller Material: | Cast Iron, A48 Class 35B or Hard Iron, A 532 ALLOY III A (25% Chrome) |
| Impeller Wear Ring (Y/N): | N |
| Shaft Material: | 420 or 431 Stainless Steel |
| Material: | N/A |
| Minimum discharge port: | 3” (inch) |
| Guide Rail Material: | Double, SST |
| Lifting Chain Material: | 316 SST |
| Pump Removal Hoist (Y/N): | Y |
| Motor Hoist power: | N/A |
| Enclosure Type: | Submersible |
| Load Class: | | |
| Synchronous Speed: | 1800 rpm max |
| Service Factor: | 1.0 1.15 |
| Multispeed, Two speed: | | |
| Variable Speed Drive: | See Division 26, ELECTRIC. Provide Inverter Duty Rated Motors. |
| Windings: | One Two |
| Thermal protection embedded in windings. | |
| Motor nameplate horsepower shall not be exceeded at any operational point. | |
| Provide | Space Heater |
| Oversize main terminal (conduit) box for motors | |
| Moisture detection switches. | | |

## MOTOR DATA

| Type: | Squirrel-cage induction meeting requirements of NEMA MG1. |
| Manufacturer: | For multiple units of the same type of equipment, furnish motors and accessories of a single manufacturer. |
| Hazardous Location: | Furnish motors for hazardous (classified) locations that conform to UL 674 and have an applied UL listing marking |
| Motor Horsepower: | 2 |
| Voltage: | 460 |
| Phase: | 3 |
| Frequency: | 60 Hz |
| Synchronous Speed: | 1800 rpm max |
| Service Factor: | 1.0 1.15 |
| Multispeed, Two speed: | | |
| Variable Speed Drive: | See Division 26, ELECTRIC. Provide Inverter Duty Rated Motors. |

## SPECIAL FEATURES / NOTES

See Division 40 for general instrumentation and control requirements. Provide one pump repair kit for each pump type and special tools needed to dismantle pumps.
PART 1 - GENERAL

1.1 SUMMARY

A. This section includes the Work necessary to furnish all labor, materials, equipment and incidentals required to provide one (1) recessed impeller grit pump, complete and operational with all appurtenances as specified herein and/or as shown on the plans. The pump shall be specifically designed to pump slurries of grit, debris, and organic solids without clogging.

B. Equipment specified within the following sections shall be coordinated and supplied by a single manufacturer:
   1. Section 44 42 40 – Grit Classifier
   2. Section 44 42 56.60 – Induced Flow (Recessed Impeller) Centrifugal Pump

C. Related Sections:
   1. Section 01 33 00 – Submittal Procedures.
   2. Section 01 60 00 – Product Requirements.
   3. Section 01 78 23 – Operation and Maintenance Data.
   4. Section 01 79 00 – Demonstration and Training.
   5. Section 05 50 00 – Metal Fabrications.
   6. Division 26 – Electrical.

1.2 COSTS OF PRE-NEGOTIATED ITEMS

A. Owner has entered into a pre-negotiated cost agreement with the specified manufacturer for some items in this section of the specification. Refer to Attachment “A” BID FORM for more details. The pre-negotiated cost agreement and proposal from the specified manufacturer is provided as an attachment to this specification section. The Contractor shall carefully review the pre-negotiated proposal and scope of supply to determine those items required by the Contract Documents which are not part of the proposal or specified manufacturer’s scope of supply. In addition to the pre-negotiated costs indicated in Attachment “A” BID FORM, the Contractor shall include in the Lump Sum Bid Price the costs for the following:
   1. All items not specifically itemized in the manufacturer’s scope of supply provided as part of the pre-negotiated proposal but required by the Contract Documents and/or necessary to provide a complete and operational system.
   2. All items specifically itemized in the manufacturer’s scope of supply provided as part of the pre-negotiated proposal which are designated to be provided by others, provided by the customer, provided by the Owner, or any similar designation.
   3. All labor, materials, and all other associated costs not included in the pre-negotiated proposal but required by the Contract Documents and required to provide a complete and operational system.

1.3 GENERAL

A. Equipment Numbers: 10P301, 10P302, 10P303

B. Like items of equipment provided hereinafter shall be the end products of one manufacturer to achieve standardization of appearance, operation, maintenance, spare parts, and manufacturer’s services.

C. Unit Responsibility: The Work requires that the pumps, and components complete with all accessories and appurtenances be the end product of one responsible system manufacturer or
responsible system supplier. Unless otherwise indicated, the Contractor shall obtain each system from the responsible supplier of the equipment, which supplier shall furnish all components and accessories of the system to enhance compatibility, ease of operation and maintenance, and as necessary to place the equipment in operation in conformance with the specified performance, features, and functions without altering or modifying the Contractor's responsibilities under the Contract Documents. The Contractor is responsible to the Owner for providing the equipment systems as specified herein.

D. General Requirements: See Division 01, GENERAL REQUIREMENTS, which contains information and requirements that apply to the work specified herein and are mandatory for this project.

1.4 SUBMITTALS

A. General: Administrative, shop drawings, samples, quality control, and contract closeout submittals shall conform to the requirements of Section 01 33 00, SUBMITTAL PROCEDURES.

B. In addition to the requirements of Section 01 33 00, SUBMITTAL PROCEDURES, submit the following additional specific information:

1. Shop Drawings:
   a. Make, model, weight, and horsepower of each component.
   b. Manufacturer's catalog information, descriptive literature, specifications, and identification of materials of construction.
   c. Detailed mechanical, and electrical drawings showing the equipment fabrications and interface with other items. Include dimensions, size, and details of anchorage and of connections to other work, and weights of associated equipment.
   d. Pump curve showing specified performance point.
   e. External utility requirements (quantity and connection details) such as air, water, power, drain etc., for each component.
   f. Motor nameplate data, motor manufacturer, and any motor modifications.
   g. Wiring diagrams for motors, including terminals and numbers.
   h. Suggested spare parts list to maintain the equipment in service for a period of 1 year and 5 years. Include a list of special tools required for checking, testing, parts replacement, and maintenance with current price information.
   i. List of special tools, materials, and supplies furnished with equipment for use prior to and during startup and for future maintenance.
   j. Instrumentation and Control Submittals: In conformance with Division 26.

2. Quality Control Submittals:
   a. Manufacturer's Certificate of Compliance: Commercial products, including painting/coating systems.
   b. Special shipping, storage and protection, and handling instructions.
   c. Test procedures.
   d. Test results, reports, and certifications.
   e. Manufacturer's Certificate of Proper Installation.
   f. Operation and maintenance manual.


1.5 QUALITY CONTROL

A. Balancing: Rotating elements of equipment, except small, commercially packaged equipment, shall be statically and dynamically balanced at the factory prior to final assembly. The Contractor shall furnish certified copies of all test results.
1.6 OPERATION AND MAINTENANCE DATA
A. O&M Manuals: Content, form, and schedule for providing as specified in Section 01 78 23, OPERATION AND MAINTENANCE DATA.
B. Maintenance Summary Forms: As specified in Section 01 78 23, OPERATION AND MAINTENANCE DATA.

1.7 WARRANTY
A. Provide warranty for a period of 12 months after the final acceptance of the equipment by the Owner and Engineer. The warranty shall stipulate that the equipment furnished is suitable for the purpose intended and free from defects of material and workmanship for the duration of the warranty. In the event the equipment fails to perform as specified, the Manufacturer will promptly repair or replace the defective equipment without additional cost to the Owner.
B. Spare parts identified within this specification shall not be used to address warranty repairs.

PART 2 - PRODUCTS

2.1 MANUFACTURERS
A. Where a manufacturer's standard equipment name and/or model number is listed, the equipment system shall be provided and modified as required to conform to the performance, functions, features, and materials of construction as specified herein.
B. Materials, equipment, components, and accessories specified in this section shall be, products of:
1. Wemco, Model C

2.2 SUPPLEMENTS
A. See supplements to this section for additional equipment system product, component or accessory information.

2.3 SERVICE CONDITIONS
A. The grit pump shall be designed for continuous operation and will be operated continuously under normal service.

2.4 SYSTEM PERFORMANCE AND FUNCTIONAL REQUIREMENTS
A. Since these pumps will be used to pump abrasive grit and other solids, the pumps shall be specifically designed to both optimize wear resistance and then maintain hydraulic performance as wear occurs.
B. The pump(s) shall be of a fully recessed, slurry type design, with the impeller mounted completely out of the flow path between the pump inlet and discharge connection, so that solids are not required to flow through the impeller. All flow path clearances within the pump(s) shall be equal to or greater than the discharge diameter, so that all solids which will pass through the discharge will pass through the pump.
## 2.5 EQUIPMENT AND/OR MATERIALS

### A. Impeller

1. The impeller shall be constructed of 650 Brinell Ni-Hard or Hi-Chrome Iron and specifically designed to maintain hydraulic pumping performance as wear occurs.
2. The impeller shall be of cup design such that the deepest portion of the vane is not located at the vane tips and the tips are surrounded by a thick-sectioned rim of the following thickness:

<table>
<thead>
<tr>
<th>Location</th>
<th>Pump Size (in.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Min. Impeller Diameter @ Outside Rim (in.)</td>
<td>3</td>
</tr>
<tr>
<td>Minimum Rim Thickness @ Wear Area (in.)</td>
<td>1-1/8</td>
</tr>
<tr>
<td>Minimum Vane Thickness @ Wear Area (in.)</td>
<td>7/8</td>
</tr>
<tr>
<td>Impeller MinimumNi-Hard or Hi-ChromeIron Weight (lb)</td>
<td>60</td>
</tr>
</tbody>
</table>

3. The hydraulic design shall be such that the length of the impeller vane increases as wear occurs to the rim, allowing as-new or better pumping performance throughout the wear cycle of the impeller.
4. The hydraulic design of the impeller shall preferentially direct flow to a sacrificial, independently replaceable suction piece. The suction piece shall be easily accessible and replaceable, without the need to disassemble any other component of the pump.
5. Pump-out vanes on the rear shroud of the impeller are not acceptable. Impellers of the radial design that incorporate the impeller in a recessed portion of the volute or wearplate are not acceptable.
6. A removable wearplate of Ni-Hard or Hi-Chrome Iron shall be provided behind the impeller designed to direct flow from behind the impeller to the center of the volute for maximum protection to the casing.
7. The packing housing shall be a separate piece bolted to the bearing housing for ease of removal. Designs that incorporate the stuffing box as an integral part of the wear plate and/or backplate assembly are not acceptable.
8. The pump casing shall be of the two-piece radially split type, with a separate and removable suction piece designed so that the impeller can be withdrawn without the need to remove the discharge casing or disturb the discharge piping. The casing shall be constructed so that it can be reversed for opposite rotation and shall be of Ni-Hard or Hi-Chrome Iron. To insure a liberal wear allowance, the casing and suction piece shall be constructed, and the entire wet end weights shall be, as follows:

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Discharge Diameter (in.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Casing Minimum (in.)</td>
<td>3</td>
</tr>
<tr>
<td>Suction Piece @ Wear Area (in.)</td>
<td>9/16</td>
</tr>
<tr>
<td>Weight of Wearing Parts (lbs)</td>
<td>1</td>
</tr>
<tr>
<td>(Suction piece, impeller, casing, and wearplate,)</td>
<td>340</td>
</tr>
</tbody>
</table>

9. The pump's head vs. capacity curve shall slope upward toward shutoff in one continuous curve with no points of inflection capable of causing hunting at any pump operational speed.
10. Pump(s) shall be equipped with slotted raised-face flanges to receive 125 lb. standard bolting. Special case slots shall be cast in to retain bolts and to fasten the case to the bearing housing and to the intake for easy case removal.

### B. MATERIALS OF CONSTRUCTION

1. The parts exposed to abrasive wear - case, removable suction piece, impeller, and wearplate shall be of all Ni-Hard or Hi-Chrome Iron material conforming to ASTM
Designation A532-75 Class I or Class III, Type A, and be a minimum of 650 Brinell hardness for maximum wear resistance. Brinell values below this are not acceptable.

2. Test bars shall be cast integrally with the case and suction piece and shall remain attached to the casting upon final delivery to the owner. Test bars shall be of sufficient thickness to represent the average thickness of the cast part. After receipt of final delivery, the owner may at any time prior to the final acceptance, remove the test bar and independently verify compliance to the material and hardness specification. Failure of the tested bars to meet the specified requirements shall be cause for rejection.

C. BEARING HOUSING
1. The bearing housing shall be of cast iron, ASTM A48CL-25.
2. The shaft shall be of ASTM A108, Grade 1045 (or equal) steel.
3. Bearings shall be oil bath lubricated. The oil reservoir shall be sealed at both ends to prevent entrance of foreign matter. The thrust bearings shall consist of three angular contact ball bearings for maximum protection from all thrust loads. The bearing housing will be equipped with a pressure venting device and oil fill and drain taps. A built-in sight glass shall be furnished to check proper oil level. The bearings shall be rated for a minimum B10 life of 100,000 hours, without credit for any rear pump-out vanes to balance hydraulic thrust.

D. SHAFT SEALING
1. Mechanical Seal
   a. A single cartridge mechanical seal requiring no external flushing shall be furnished in the pump. The seal shall utilize a rotational sealing ring mounted in an elastomer cup with an o-ring mounted stationary ring loaded by a non-fouling, conical spring encapsulated in Viton. Installation of the seal shall require no measurements or scribe marks on the shaft.
   b. The rotational sealing ring shall be made of tungsten carbide Grade VC 805, the surface of which shall be lapped to a flatness not to exceed three helium light bands. The sealing ring shall be bonded inside a Viton rubber cup, which shall have three (3) integrally molded anti-rotational lugs to prevent the rotary seal face from turning within the rotary body. Additionally, the rotary body shall have three (3) 1/8" solid stainless steel pins to also prevent the rotary seal face from turning within the rotary body.
   c. The stationary sealing ring shall also be constructed of tungsten carbide Grade VC 805. The surface shall be lapped to a flatness not to exceed three helium light bands. The stationary ring shall have a slot milled on the side opposite of the mating side, which engages an anti-rotation pin. Stationary sealing rings of converted carbon or other surface-only treatments are not acceptable.
   d. The spring that loads the rotational sealing ring shall be cone-type, non-fouling design and shall run in the pumped product without fouling or hang-up. The spring metal material shall be SAE1095 Carbon Steel, ASTM A-682 heat-treated to a Rockwell C hardness of 45 to 50 and be totally encapsulated in Viton for protection from the pumped fluid. The product side of the spring shall have a minimum 1/4" thick Viton rubber covering for corrosion/abrasion protection. Seals which use single coil, multiple coil, bellows, and rubber-in-shear designs are not acceptable.
   e. To minimize the number of points where the slurry must be sealed, the mechanical seal assembly shall have no more than three (3) o-rings: one (1) shaft sleeve o-ring, one (1) stationary face o-ring, and one (1) retainer o-ring. O-rings are to be made of Viton. Seals using more than three (3) o-rings are not acceptable.
   f. All metal components not encapsulated in Viton shall be constructed of abrasion resistant CD4MCu ASTM A-743. Surface finish shall be a maximum of 64 RMS.
   g. The seal shall be capable of running with up to ± 0.025" radial shaft deflection and ± 0.040" axial shaft deflection without leakage, damage, or loss of performance.
   h. A seal chamber of Hi-chrome iron, ASTM A-532, minimum 600 Brinell, shall be provided to mount the seal and to provide a reservoir of adequate volume for the
pumped product to contact and to lubricate the seal faces. The seal shall be installed into the seal chamber from the impeller side of the pump so that only the casing/suction piece and impeller need to be removed to gain complete access to the seal for inspection and/or maintenance.

E. MOUNTING
1. Belt Drive
   a. The pump manufacturer shall provide a common pump and motor base, constructed of a minimum 3/8 inch thick fabricated steel, suitably reinforced to support the full weight of the pump, motor, belt drive and guards. Pumps shall be standard left hand motor mount as shown on the drawings.
   b. The pump manufacturer shall furnish and install a separate, adjustable motor base with handwheel adjustment so that the motor can be easily moved for V-belt tensioning and adjustment, TB Woods type MC 3B, modified with a welded steel gusset, or equal.
   c. The pump manufacturer shall supply and install belts and sheaves to drive the pump at the speed necessary to meet the rated conditions.
   d. The drive shall be of the stationary control variable speed TB Woods type ‘SVS’ or equal, which allows a speed change by means of an adjustment to the motor sheave when the drive is not in operation.
   e. An approved fiberglass or thermoplastic belt guard shall be provided to safely enclose the belt drive. If metal guards are furnished, they shall be of all 316 stainless steel construction with suitable lifting eyes and handles to aid in removal.

F. MOTOR
1. All motors shall be of nationally known manufacture and shall conform to NEMA standards and specifications.

2.6 TOOLS AND SPARE PARTS

A. Tools: The work includes one complete set of special tools recommended by the manufacturer for maintenance and repair of each separate type of equipment; tools shall be stored in tool boxes, and identified with the equipment number by means of stainless steel or solid plastic name tags attached to the box.

B. Spare Parts:
1. All equipment shall be furnished with the specified manufacturers spare parts, as indicated in the individual equipment sections.
2. Spare parts shall be tagged by project equipment number and identified as to part number, equipment manufacturer, and subassembly component (if appropriate). Spare parts subject to deterioration such as ferrous metal items and electrical components shall be properly protected by lubricants or desiccants and encapsulated in hermetically sealed plastic wrapping. Spare parts with individual weights less than 50 pounds and dimensions less than 2 feet wide, or 18 inches high, or 3 feet in length shall be stored in a wooden box with hinged wooden cover and locking clasp. Hinges shall be strap type. The box shall be painted and identified with stenciled lettering stating the name of the equipment, equipment numbers, and the words "spare parts." A neatly typed inventory of spare parts shall be taped to the underside of the cover.

2.7 FABRICATION

A. Shop Assembly: The system shall be test-run, fully assembled, in the factory before shipment. Submit test results to Engineer for review prior to shipment.

B. Shop/Factory Finishing: Shop prime coatings shall conform to the requirements of Section 09 90 00, PAINTING AND PROTECTIVE COATINGS.
PART 3 - EXECUTION

3.1 GENERAL

A. Coordination shall include space and structural requirements, clearances, utility connections, signals, outputs and features required by the manufacturer including safety interlocks.

3.2 ASSEMBLY AND PREPARATION FOR SHIPMENT

A. Each unit, including motor, shall be completely factory assembled, aligned, and securely crated for shipment. Accessory equipment which cannot be shipped assembled to the unit, such as shafts, baseplates, impellers, spare parts, and anchorage materials, shall be separately crated, clearly marked as to the contents, and shipped on the same shipment as the drives.

B. For shipment, exposed surfaces subject to rust, such as mounting flange faces, etc., shall be covered with a rust-preventive compound such as Kendall No. 5, or equal.

3.3 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. Comply with Section 01 66 00, PRODUCT STORAGE AND HANDLING REQUIREMENTS.

B. Delivery of Materials: Products shall be delivered in original, unbroken packages, containers, or bundles bearing the name of the manufacturer.

C. Storage: Products shall be carefully stored in a manner that will prevent damage and in an area that is protected from the elements.

D. Protection of Equipment: Equipment shall be boxed, crated, or otherwise protected from damage and moisture during shipment, handling, and storage. Equipment shall be protected from exposure to corrosive fumes and shall be kept thoroughly dry at all times. Pumps, motors, drives, electrical equipment, and other equipment with anti-friction or sleeve bearings shall be stored in weathertight and heated storage facilities prior to installation. For extended storage periods, plastic equipment wrappers shall not be used to prevent accumulation of condensate in gears and bearings.

3.4 INSTALLATION

A. As shown on the Drawings. All anchors, bolts, and accessories shall be 316 stainless steel. The manufacturer shall provide templates for anchor bolt locations.

B. Contractor will install the equipment according to the Contract Documents, following the instructions detailed in the Installation Operation and Maintenance manual.

C. Lubricants: Include oil and grease for initial operation.

3.5 FIELD QUALITY CONTROL

A. Field Test
   1. During plant start-up all equipment described herein shall be inspected for proper connections and satisfactory performance by means of a function test.
   2. The equipment system and associated accessories shall be field tested to verify adequate performance.
   3. Units apparently failing to meet the Specifications must be corrected to provide proper service. Should the problem persist due to a flaw in material and/or in the design of the equipment, new equipment must be provided by the Contractor to meet the specifications.
B. Functional Tests: Conduct on each pump.
   1. Alignment: Test complete assemblies for correct rotation, proper alignment and connection, and quiet operation.
   2. Vibration Test:
      a. Test with units installed and in normal operation and discharging to the connected piping systems at rates between the low discharge head and high discharge head conditions specified, shall not develop at any frequency or in any plane, peak-to-peak vibration amplitudes in excess of 3 mils.
      b. If units exhibit vibration in excess of the limits specified adjust or modify as necessary. Units that cannot be adjusted or modified to conform as specified shall be replaced.
   3. Flow Output: Measured by facility instrumentation and storage volumes.

C. Performance Test: In accordance with Hydraulic Institute Standards and Section 01 79 00, Demonstration and Training.

3.6 MANUFACTURER’S SERVICES

A. A manufacturer’s representative for the equipment specified herein shall be present at the job site for the minimum person-days listed for the services hereinafter, travel time excluded:
   1. Installation, Startup, and Testing Services:
      a. 1 person for two, eight-hour days for installation assistance, inspection, and Certificate of Proper Installation.
      b. 1 person for one, eight-hour day for functional and performance testing.
      c. Provide Qualifications of Manufacturer’s employee.
   2. Training Services:
      a. 1 person for one, eight-hour day of prestart classroom or jobsite training of Owner’s personnel.
      b. Training of Owner’s personnel shall be at such times and at such locations as required and approved by the Owner.

B. See Section 01 79 00, DEMONSTRATION & TRAINING of Division 01, GENERAL REQUIREMENTS.

3.7 MANUFACTURER’S CERTIFICATES

A. Provide Manufacturer’s certificate(s) in accordance with Section 01 79 00, DEMONSTRATION AND TRAINING, of Division 01, GENERAL REQUIREMENTS.

3.8 SUPPLEMENTS

A. The supplements listed below following “END OF SECTION” are a part of this Specification.
   1. Section 44 42 56.60 – Induced Flow (Recessed Impeller) Centrifugal Pump Data Sheet

END OF SECTION
**Section 44 42 56.60.1 – Induced Flow (Recessed Impeller) Centrifugal Pump Data Sheet**

<table>
<thead>
<tr>
<th>PROJECT:</th>
<th>Western Area WWTP Phase 1 Expansion</th>
</tr>
</thead>
<tbody>
<tr>
<td>OWNER:</td>
<td>City of Huntsville</td>
</tr>
<tr>
<td>EQUIPMENT NAME(S):</td>
<td>Grit Pump 1, 2, 3</td>
</tr>
<tr>
<td>EQUIPMENT TAG NUMBER(S):</td>
<td>10P301, 10P302, 10P303</td>
</tr>
<tr>
<td>CONTROL PANEL(S):</td>
<td>GTCP1</td>
</tr>
<tr>
<td>TOTAL PUMPS REQUIRED:</td>
<td>3</td>
</tr>
</tbody>
</table>

**MANUFACTURERS**

| Wemco | Model C |

**SERVICE CONDITIONS**

| Liquid Pumped: | Grit Slurry |
| Specific Gravity at 60 deg F: | 0.99 – 1.20 |
| Largest dia. Solid pump shall be capable of passing: | 4 inch |
| Min. NPSH available: | - |
| Explosion Proof (Y/N): | Y |
| Pumping Temperature (°F): | 40 – 68 °F |
| Max pump speed at rated capacity: | 1200 rpm |

**PERFORMANCE REQUIREMENTS**

| Capacity (US gpm): Single Pump Operational Range (with VFD): | - |
| Capacity (US gpm): Rated: | 250 |
| Total Dynamic Head (ft): Single Pump Operational Range (with VFD): | - |
| Total Dynamic Head (ft): Rated: | 40 |
| Min. rated pump hydraulic efficiency at rated capacity (%): | 28.96 |

**EQUIPMENT DESCRIPTION**

| Casing Material: | 650 Brinell Ni-Hard or Hi-Chrome |
| Casing Wear Ring Material: | 650 Brinell Ni-Hard or Hi-Chrome |
| Impeller Type: | Cupped Recessed Impeller |
| Impeller Material: | 650 Brinell Ni-Hard or Hi-Chrome |
| Impeller Wear Ring (Y/N): | Wear Plate Type, Ni-Hard or Hi-Chrome |
| Material: | Ni-Hard or Hi-Chrome |
| Guide Rail Material: | N/R |
| Lifting Chain Material: | N/R |
| Pump Removal Hoist (Y/N): | N |
| Shaft Material: | Mechanical Slurry seal (no external flush) |

**MOTOR DATA**

| Type: | Squirrel-cage induction meeting requirements of NEMA MG1. |
| Manufacturer: | For multiple units of the same type of equipment, furnish motors and accessories of a single manufacturer. |
| Hazardous Location: | Furnish motors for hazardous (classified) locations that conform to UL 674 and have an applied UL listing marking |
| Motor Horsepower: | 15 Maximum |
| Voltage: | 460 |
| Phase: | 3 |
| Frequency: | 60 Hz |
| Synchronous Speed: | 1200 rpm max |
| Service Factor: | 1.0 1.15 |
| Windings: | One Two |
| Thermal protection embedded in windings: | ☑ |
| Motor nameplate horsepower shall not be exceeded at any operational point: | ☑ |

**SPECIAL FEATURES / NOTES**

See Division 40 for general instrumentation and control requirements.
See Section 26 24 19 MOTOR CONTROL CENTERS for additional requirements.
Provide one set of mechanical seals, bearings, and O-rings required to replace each pump and special tools needed to dismantle pumps.
DIVISION 46
WATER AND WASTEWATER EQUIPMENT
SECTION 46 21 26 – STEP SCREENS

PART 1 - GENERAL

1.1 SUMMARY

A. This section includes the Work necessary to completely furnish and install the step screen system including all related equipment, material, and appurtenances as shown on the drawings and specified herein.

B. Equipment specified within the following sections shall be coordinated and supplied by a single manufacturer:
   1. Section 44 42 27.20 – Screenings Washer Compactor
   2. Section 46 21 26 – Step Screen
   3. Section 46 21 60 – Water Sluice System

C. Related sections:
   1. Section 01 33 00 – Submittals
   2. Section 01 60 00 – Product Requirements
   3. Section 01 78 23 – Operation and Maintenance Data
   4. Section 01 79 00 – Demonstration and Training
   5. Section 26 05 33 – Raceways, Boxes, Enclosures, and Fittings

1.2 COSTS OF PRE-NEGOTIATED ITEMS

A. Owner has entered into a pre-negotiated cost agreement with the specified manufacturer for some items in this section of the specification. Refer to Attachment “A” BID FORM for more details. The pre-negotiated cost agreement and proposal from the specified manufacturer is provided as an attachment to this specification section. The Contractor shall carefully review the pre-negotiated proposal and scope of supply to determine those items required by the Contract Documents which are not part of the proposal or specified manufacturer’s scope of supply. In addition to the pre-negotiated costs indicated in Attachment “A” BID FORM, the Contractor shall include in the Lump Sum Bid Price the costs for the following:
   1. All items not specifically itemized in the manufacturer’s scope of supply provided as part of the pre-negotiated proposal but required by the Contract Documents and/or necessary to provide a complete and operational system.
   2. All items specifically itemized in the manufacturer’s scope of supply provided as part of the pre-negotiated proposal which are designated to be provided by others, provided by the customer, provided by the Owner, or any similar designation.
   3. All labor, materials, and all other associated costs not included in the pre-negotiated proposal but required by the Contract Documents and required to provide a complete and operational system.

1.3 GENERAL

A. Equipment Numbers: 10SCR1, 10SCR2, 10SCR3, 10SCR4

B. Like items of equipment provided hereinafter shall be the end products of one manufacturer to achieve standardization of appearance, operation, maintenance, spare parts and manufacturer’s services.

C. Unit Responsibility: The Work requires that the step screens, local control panel, instruments, and components complete with all accessories and appurtenances be the end product of one responsible system manufacturer or responsible system supplier. Unless otherwise indicated, the Contractor shall obtain each system from the responsible supplier of the equipment. The
supplier shall furnish all components and accessories of the system to enhance compatibility, ease of operation and maintenance, and as necessary to place the equipment in operation in conformance with the specified performance, features, and functions without altering or modifying the Contractor’s responsibilities under the Contract Documents. The Contractor is responsible to the Owner for providing the equipment systems as specified herein and in the pre-negotiated agreement which is provided as an attachment to this specification section.

D. General Requirements: See Division 01, GENERAL REQUIREMENTS, which contains information and requirements that apply to the work specified herein and are mandatory for this project.

1.4 SUBMITTALS

A. General: Administrative, shop drawings, samples, quality control, and contract closeout submittals shall conform to the requirements of Section 01 33 00, SUBMITTAL PROCEDURES.

B. In addition to the requirements of Section 01 33 00, SUBMITTAL PROCEDURES, submit the following additional specific information:

1. Shop Drawings:
   a. Make, model, weight, and horsepower of each component.
   b. Manufacturer's catalog information, descriptive literature, specifications, and identification of materials of construction.
   c. Detailed mechanical, and electrical drawings showing the equipment fabrications and interface with other items. Include dimensions, size, and details of anchorage and of connections to other work, and weights of associated equipment.
   d. Gear output torque and screen lifting capacity calculations.
   e. External utility requirements (quantity and connection details) such as air, water, power, drain etc., for each component.
   f. Motor nameplate data, motor manufacturer, and any motor modifications.
   g. Wiring diagrams for motors, including terminals and numbers.
   h. Suggested spare parts list to maintain the equipment in service for a period of 1 year and 5 years. Include a list of special tools required for checking, testing, parts replacement, and maintenance with current price information.
   i. List of special tools, materials, and supplies furnished with equipment for use prior to and during startup and for future maintenance.
   j. Instrumentation and Control Submittals: In conformance with Division 40.
   k. Provide complete headloss calculation sheets and outputs, including peak and average flow scenarios, with 10%, 30%, 50%, and 70% blinded conditions.

2. Quality Control Submittals:
   a. Manufacturer's Certificate of Compliance: Commercial products, including painting/coating systems.
   b. Special shipping, storage and protection, and handling instructions.
   c. Test procedures.
   d. Test results, reports, and certifications.
   e. Manufacturer's Certificate of Proper Installation.
   f. Operation and maintenance manual.


1.5 QUALITY CONTROL

A. The materials covered under these specifications are intended to be standard equipment of proven reliability and as manufactured by a reputable manufacturer having experience in the production of screening equipment. The equipment furnished shall be designed and constructed in accordance with the best practices and methods and shall operate satisfactorily when installed as shown on the Contract Drawings and operated per the manufacturer’s recommendations.
B. Fabrication shall be done in compliance with all applicable ASTM standards or equivalent international standards.

1.6 OPERATION AND MAINTENANCE DATA

A. O&M Manuals: Content, format, and schedule for providing as specified in Section 01 78 23, OPERATION AND MAINTENANCE DATA.

B. Maintenance Summary Forms: As specified in Section 01 78 23, OPERATION AND MAINTENANCE DATA.

1.7 WARRANTY

A. Provide warranty for a period of 12 months after the final acceptance of the equipment by the Owner and Engineer. The warranty shall stipulate that the equipment furnished is suitable for the purpose intended and free from defects of material and workmanship for the duration of the warranty. In the event the equipment fails to perform as specified, the Manufacturer will promptly repair or replace the defective equipment without additional cost to the Owner.

B. Spare parts identified within this specification shall not be used to address warranty repairs.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Where a manufacturer's standard equipment name and/or model number is listed, the equipment system shall be provided and modified as required to conform to the performance, functions, features, and materials of construction as specified herein.

B. Materials, equipment, components, and accessories specified in this section shall be products of:
   1. Huber – SSF-HF 5000x1126/6

2.2 GENERAL REQUIREMENTS

A. Noise Level: When in operation, no piece of equipment shall exceed the noise level requirements for a 1-hour exposure at 80 dBA.

B. Service Factors: Service factors shall be applied in the selection and design of components where so indicated in individual sections. When not indicated there, minimum service factors shall be 1.25, except for gears and gear drives as specified herein.

C. Safety Devices: The completed work shall include all necessary permanent safety devices, such as machinery guards, emergency stops and similar items required by OSHA, and other federal, state, and local health and safety regulations.

D. Flanges and Pipe Threads: Comply with ANSI B 16.1, Class 125; or B 16.5, Class 150, unless otherwise indicated. Threaded flanges and fittings shall have standard taper pipe threads complying with ANSI/ASME B 1.20.1.

E. Bearings:
   1. Conform to the standards of the Anti-Friction Bearing Manufacturers Association, Inc. (AFBMA).
   2. Except where otherwise indicated, bearings of process equipment shall have a minimum L-10 life expectancy of 100,000 hours.
F. Gears and Gear Drives:
   1. Except as otherwise indicated, gears shall be of the helical or spiral-bevel type, designed and manufactured in accordance with AGMA Standards, with a minimum service factor of 1.7, a minimum L-10 bearing life of 60,000 hours, and a minimum efficiency of 94 percent.
   2. Gear speed reducers or increasers shall be of the enclosed type, oil- or grease-lubricated and fully sealed, with a breather to allow air to escape but keep dust and dirt out. The casing shall be of cast iron or heavy-duty steel construction with lifting lugs and an inspection cover for each gear train. A bullseye style sight glass and an oil flow indicator shall be provided and installed for easy reading.
   3. Gears and gear drives as part of an equipment assembly shall be shipped fully assembled for field installation.
   4. Material selections shall comply with AGMA values and the manufacturer's recommendations. Input and output shafts shall be properly designed for the service and load requirements. Gears shall be computer-matched for minimum tolerance variation. The output shall have two positive seals to prevent oil leakage.
   5. Oil level and drain location shall be readily accessible.
   6. Where gear drive input to output shafts connect to couplings or sprockets, the gear drive manufacturer shall supply matching key.

G. Anchor bolts shall be stainless steel straight threaded rods complying with ASTM F593, AISI Type 316, Condition A, with ASTM F594, AISI Type 316, stainless steel nuts. Provide ASTM A194/A194M, Grade 8S (Nitronic 60) stainless steel nuts where required. Other AISI types may be used when approved by Engineer. Threaded rods shall comply with ductility requirements of ACI 350 or ACI 318 Appendix D, Section D.3.3. Hooked Bolts are unacceptable. Anchorage number, size and design shall be by the screen manufacturer.

H. Stainless Steel: Stainless steel components shall be 316 stainless steel, or higher, as specified.

I. Nameplates: Equipment nameplates of 316 stainless steel shall be engraved or stamped and fastened to the equipment in accessible locations with 316 stainless steel screws or drive pins. Nameplates shall contain the manufacturer's name, model, serial number, size, characteristics, and appropriate data describing the machine performance ratings.

2.3 SERVICE CONDITIONS

A. Each screen will be located in the Headworks Screen Facility in a channel that is 4.5-feet wide and 6.0-feet deep, as shown in the drawings.

B. The step screens will be required to remove material from raw sewage. This material includes rocks, grit, rags, hair, paper products, plastic products, and any and all material up to 9 inches in diameter.

C. There will be a high level of hydrogen sulfide present.

2.4 SYSTEM PERFORMANCE AND FUNCTIONAL REQUIREMENTS

A. System Definition
   1. The system will consist of four (4) step screens and (4) local control stations for each screen.
   2. The entire headworks system shall be designed to handle 87.5 MGD with four screens in service.
   3. The screenings will be discharged into a sluiceway, and then travel to a washer/compactor. The downstream equipment (sluiceway and washer/compactor) are not included in this specification.
4. The configuration and location of the systems and their components shall be as shown on the Drawings.
5. Each system shall include components and accessories which are required for a fully functioning system.

B. Downstream Hydraulics
1. The bottom floor elevation of the screen channels is: 591.50 feet ELE. The operating floor elevation is: 597.50 feet ELE.
2. The hydraulics of the system are as follows: The downstream water elevation is controlled by the effluent weir gate at the headworks distribution structure. The water level downstream of the screens fluctuates as a function of the flow rate, number of grit basin units online, and number of screens online. There are three total grit basins and four total screens that could be online.
3. Table 1 indicates the downstream water level at the various conditions.

<table>
<thead>
<tr>
<th>Number of Grit Basins Online</th>
<th>Number of Screens Online</th>
<th>Average Flow</th>
<th>Peak Flow</th>
</tr>
</thead>
<tbody>
<tr>
<td>Three</td>
<td>Four</td>
<td>2.15 ft</td>
<td>2.95 ft</td>
</tr>
</tbody>
</table>

C. Step Screen
1. Remove, collect, elevate, and discharge screenings through a discharge chute into the sluiceway that is at floor level.
2. Hydraulic flows to screen facility:
   a. Peak Flow: 87.5 MGD
   b. Average Flow: 35 MGD
3. Screen Hydraulics:
   a. Maximum flow to one screen: 17.5 MGD
   b. Set point for maximum screenings capture: 8.0 inches differential
   c. Maximum head loss at peak flow: 11.05 inches at 35% blinding
   d. Provide all hydraulic calculations.
   e. Velocity through the screen shall always be less than 4.0 feet per second (fps).
   f. Channel velocity upstream of the screen shall be between 2.4 fps and 3.53 fps.
   g. A face plate should be provided that covers the entire bottom step. This face plate height should be included in the headloss calculations and shown in the headloss calculations under a separate line item.
   h. Maximum downstream water depth in channel is 3.0 feet. There shall be no components that need lubrication below 6.0 feet.
4. The steps should be capable of conveying a 9-inch diameter material up the face of the screen.
5. Furnish a screen with discharge chute/hopper such that the screenings discharge is fully compatible with the screenings sluiceway system.

2.5 EQUIPMENT AND/OR MATERIALS

A. Materials:
1. All structural steel components shall conform to the requirements of “Specifications for the Design, Fabrication and Erection of Structural Steel for Buildings” published by the American Institute of Steel Construction.
2. All components of the entire screen shall be 304 stainless steel or higher, including the drive shaft.
3. 304 stainless steel structural components and enclosure panels shall be passivated (either full dip passivation or electropolish) to remove embedded iron, surface rust, and weld burn.
4. All fasteners and hardware shall be 316 stainless steel.
5. All welding in the factory will use shielded arc, inert gas, MIG or TIG method. Add filler wire 316 to all welds to provide for a cross section equal to or greater than the parent metal. Fully penetrate butt welds to the interior surface and provide gas shielding to interior and exterior of the joint. All welds will be finished to include the following as a minimum: Remove all pointed protrusions from underside and face of welds and remove all weld spatter.
6. Field welding of stainless steel will not be permitted.
7. Bearings shall be greased ball bearing type, non-self-aligning, sealed and lubricated.

B. Step Screen
   1. Design Features:
      a. The step screens shall be a 304 stainless steel step type screen.
      b. Screen Covers and Discharge Chute: Removable 304 stainless steel protective covers shall be installed to cover the front sections of the step screens/frame that are above the channel opening. 304 stainless steel protective covers shall cover the back sections of the screens/frame that are above the channel opening. Front access covers shall be provided for any mechanical components. Covers should be removable by one person. The connection mechanism of the covers onto the screen must be quick disconnect and not require any tools. Covers should seal against the frame and mitigate air passage along sealing area.
      c. A sealing system shall be installed between the support frame and channel walls to prevent screenings from bypassing the step screen system. This sealing system shall be of a non-degradable material and shall be able to be removed and replaced with a guide frame and bolts.
      d. Side seal angles and baffles mounted to the channel are required, to provide a surface for the sealing system to rest against. These components should be stainless steel and be anchored into the concrete. The side seals should allow the screen to pivot out of the channel without the removal of the seal plates. This system is the responsibility of the screen manufacturer. This detail must be provided as part of the submittal.
      e. Any required maintenance shall be capable of being performed at the operating floor or grade level (not the channel floor).
      f. No parts of the drive system shall be in direct contact with, or exposed to, screened debris.
      g. Screened debris shall be routed to the screenings sluice flume via a covered discharge chute. The discharge chute is the responsibility of the screen manufacturer and should be coordinated and provided under this scope of work.
      h. The discharge chute shall be designed to be used with the screen when pivoted. This can be done by either:
         1) The screen being capable of pivoting while the discharge chute is installed
         2) The discharge chute being easily removable, without the use of tools, and by no more than one person, to allow a pivot.
      i. This discharge chute must be of stainless-steel construction. The chute should have a hinged door for visual access to the back of the screen; this door should be able to be opened and closed without the use of any hand tools.
      j. A directing plate will be installed at the base of the machine to prevent grit deposits from accumulating in front of the screen. This plate should either fully cover the bottom step or so designed so that deposits are directed onto the top of the bottom step. Per the manufacturer, the plate should be removable or self-relieving.
      k. The fixed lamella plates are constructed from type 304 stainless steel. The fixed lamella shall have a step profile on the upstream side and locking tabs and serrations on the downstream side. Each fixed plate shall have a UHMW or stainless steel cap at the top and bottom of the plate in order to properly maintain the lamella spacing and alignment with adjacent movable plates. On the downstream side of the unit, the locking tab of each fixed lamella plate shall fit into slotted step cradles that are
bolted to the unit frame on each side. The step cradles are slotted to maintain the spacing of the fixed lamella plates and connect them into a single fixed pack. The plates are then clamped to the step cradles to positively lock the plates in place. With the clamping plates loosened, an individual fixed plate may be removed from the pack. Lamellas should have no change in material across the length of the lamella.

l. Fixed Lamella plates thickness should be 2 mm.

m. The movable lamella plates are constructed from type 304 stainless steel. The movable lamella shall have a step profile on the upstream side and locking tabs and either serrations on the downstream side. Each movable plate shall have intermittent UHMW spacers along its length in order to properly maintain the lamella spacing and alignment with adjacent movable plates. On the downstream side of the unit, the locking tab of each movable lamella plate shall fit into slotted step cradles that are bolted to the end plates of the movable lamella pack on each side. The end plates are constructed from type 304 stainless steel. The step cradles are slotted to maintain the spacing of the movable lamella plates and connect them into a single rotating pack. The plates are then clamped to the step cradles to positively lock the plates in place. With the clamping plates loosened, an individual fixed plate may be removed from the pack.

n. Movable Lamella plates should be spaced at 6 mm.

o. Screen Inclination Angle: 53 degrees from horizontal. No other angle shall be acceptable.

p. Screens shall have the capability to pivot out of the channels as necessary without disconnecting any line, pipe, or device, except the discharge chute if necessary.

q. Do not permanently locate grease lubricated bearings within the possible wetted area of the channel.

r. Screens that do not provide the pronounced step profile over their entire length shall not be acceptable.

2. Components:

a. Structural Frame: The frame shall be manufactured of 304 stainless steel or higher quality with a minimum thickness of 5 mm. The screen frame shall not be fixed within the channel; the machine shall be allowed to pivot out of the channel for maintenance. The screen shall be supported by a pivot stand which is to be provided within this scope of work.

b. Screen: The screens will consist of 304 stainless steel elements connected in parallel with 3 mm (1/8") spacing between the bars. The steps will operate with rotating step-shaped lamellas conveying the particles upward onto fixed lamellas, which will have the screenings removed by the next rotation of the lamellas. Both the fixed and rotating lamellas will have a thickness of 2 mm and 3 mm (1/8"), respectively. All wetted parts will be of 304 stainless steel and high-density composites for maximum corrosion resistance. To reduce maintenance, no grease lubricated bearings, seals or other mechanisms are subject to operation in the flow stream. Removable front and rear covers will completely enclose the screens above the operating floor.

c. Directing Plate: The step screens shall be provided with a directing plate at the base of the machine perpendicular to flow to prevent grit and gravel deposits from accumulating below the step blades. The plate should be installed at a maximum angle of 40 degrees from horizontal.

d. Linkage Driving System: The screen shall be designed with a linkage system on each side of the unit that transfers the rotation of the drive to the moveable lamella pack without the use of chains or sprockets. Each linkage system shall consist of an eccentrically rotated excenter bearing and upper and lower rocker arm assemblies connected by solid drive plates or rods that connect to the movable pack cross members and step cradles.

e. A cable linkage drive is NOT acceptable.

f. Chain and Sprocket Driving System is NOT acceptable.
g. Gear Motor Drive Assembly: The drive unit shall be a gear motor rated for continuous duty and shall be selected to match the requirements of the particular screen. The motor shall be a minimum of 1.5 hp, 480 VAC, 60 Hz, 3 phase power, and a service factor of 1.15. The drive unit shall be direct coupled to the screen drive shaft through the gear box. Gear reducers shall meet the standards of the American Gear Manufacturers association. The drive assembly shall be capable of elevating the weight of the movable lamellas plus the maximum debris load. The screen shall be equipped with electronic overload protection to stop the screen and initiate an alarm in the event of an overload.

h. Covers: The step screens shall include 304 stainless steel covers for odor control and general plant safety. The covers shall extend from the deck level to the top of the screen. The covers on the front and back of the screen shall be easily removable and shall include a keyed locking mechanism. The covers on the sides of the screen shall be fastened in place by screws.

i. Grit Spray Wash: The screen should be provided with a grit spray wash system. This system should consist of a stainless-steel spray bar mounted integral to the toe of the screen. The spray bar should have openings that stream a jet of water in the direction of the flow of the wastewater through the screen. The water should be directed at the base of the lamellas, to flush any grit away from the base of the lamellas. The spray wash hose and supply should run inside the frame of the screen to a flexible connection at the pivot point of the screen. This flexible connection should be 10 feet long and made of braided stainless-steel hose or another flexible corrosion-resistant hose material, and provided with quick disconnects on both ends. The grit spray wash system should be provided with a NEMA 4X or C1D1 stainless steel solenoid valve to control the spray wash. A maximum of two solenoid valves will be provided for each screen if two grit spray bars are required for the size of the screens. The solenoid valve(s) will be controlled on a timer.

j. Screen Pivot Stand: The manufacturer should provide three custom pivot stands. The purpose of the stand is to hold the screen up in the horizontal position when pivoted at a 90 degree angle out of the channel. The pivot stand should have a base that allows it to rest on both sides of the channel and spans the width of the channel to rest the screen on. The stand shall be manufactured out of aluminum to decrease the weight of the stand.

k. Screen Spreader Bar: The manufacturer shall provide a spreader bar for each screen. The spreader bar shall provide a center load connection point for the screen to be lifted and pivoted by an overhead crane. This shall be manufactured out of aluminum or another corrosion-resistant, lightweight material so that the total weight of the spreader bar is less than 75 pounds.

l. All required connections for the screen (electrical, wash water, etc.) shall terminate at or near the pivot point with stainless steel whips of not less than 3 feet, and should not need to be disconnected to pivot the screen out of channel.

m. Lamella spacers must be UHMW.

2.6 ELECTRICAL COMPONENTS AND ACCESSORIES

A. General:
1. Conform with Division 26, ELECTRICAL, and Division 40, Instrumentation.
2. Provide all necessary electrical components and wiring for a complete, functional system.

B. Wiring: The Drawings and Specifications indicate the anticipated wiring for the equipment provided under this section. If additional wiring is required, or if required wiring does not match what is indicated, the Manufacturer shall make the necessary modifications to the electrical wiring and documentation as part of the lump sum price. Wiring shall meet the requirements of Division 26, Division 40, and NFPA 70. Insulation shall be rated 600 volts, minimum. Low-voltage (24V) signals shall be run in twisted, shielded pair cable.
C. Electrical Raceways: Electrical wiring shall be installed in conduit meeting the requirements of Division 26, ELECTRICAL. Raceways shall be installed in accordance with Specification 26 05 33, RACEWAYS, BOXES, ENCLOSURES, AND FITTINGS, and NFPA 70.

D. Motors:
   1. Provide squirrel-cage AC induction motors meeting the requirements of Division 26, and as specified herein.
   2. For additional specific requirements on motors, refer to the Motor Data table above.

2.7 INSTRUMENTATION AND CONTROLS

A. All instrumentation and control components shall be provided in accordance with the requirements of Division 26 and Division 40.

B. Master Control Panel
   1. The complete screening system (screening/conveying/washing/compacting) shall be provided with a master PLC control panel with HMI for overall automatic control of the system. All control components required for the operation, monitoring, and control of each screen, washer/compactor, and sluiceway shall be supplied by the mechanical stair screen manufacturer. The control panel shall be configured for future connection to a plant SCADA system over fiber media via Ethernet/IP communication. The control panel will be located outdoors, beneath a canopy as indicated in the drawings.
   2. General Requirements:
      a. Enclosure: Corrosion Resistant NEMA 4X, suitable for installation outdoors
      b. Materials: 304 Stainless Steel
      c. Power: 120 volts, single-phase, 60-Hz.
      d. Main Disconnect: Circuit breaker interlocked with door handle.
      e. Panel space heater with thermostat.
      f. Panel air conditioner.
      g. Operator Interface Terminal (OIT) touchscreen for operator interface for complete screening system.
      h. System Control Power selector switch and indicator light.
      i. Alarm horn, alarm indicator light, and reset pushbutton.
      j. Emergency Stop Mushroom Head pushbutton.
      k. Provide 120VAC circuits for powering the channel level transmitters.
      l. Receive analog signals from channel level transmitters.
      m. Provide control signals to/from sluiceway water solenoid valve.
      n. Refer to Specification 40 67 23 Control Panels for additional requirements.

C. Motor Starting Panels
   1. Each screen and washer/compactor shall be provided with a dedicated motor starting panel containing the power components associated with the equipment. These panels should interface with the master control panel through hard-wired inputs and outputs as required for control and monitoring of the equipment.
   2. General Requirements:
      a. Enclosure: Corrosion Resistant NEMA 4X, suitable for installation outdoors
      b. Materials: 304 Stainless Steel
      c. Power: 480 volts, three-phase, 60-Hz.
      d. Main Disconnect: Circuit breaker interlocked with door handle.
      e. Provide control switches and indicating lights as indicated on P&ID diagram.
      f. Refer to Specification 40 67 23, CONTROL PANELS, for additional requirements.

D. Local Control Stations
   1. Provide a local control station for each screen and washer/compactor. Local control stations shall be:
      a. NEMA 7/4X boxes: Class 1, Division 1, Groups A, B, C, and D
b. Copper free cast aluminum body and cover
c. Stainless steel hinges
d. Copper free cast aluminum body and cover
e. Stainless steel hinges

2. Step Screen Local Control Station
   a. Screen HAND/OFF/AUTO Selector Switch
   b. Emergency Stop Mushroom Head Pushbutton
   c. Wash 1 HAND/OFF/AUTO Selector Switch
d. Wash 2 HAND/OFF/AUTO Selector Switch
e. FAULT Light

3. Washer/Compactor Local Control Station
   a. W/C HAND/OFF/AUTO Selector Switch
   b. W/C FORWARD/OFF/REVERSE Selector Switch
c. Emergency Stop Mushroom Head Pushbutton
d. Wash 1 HAND/OFF/AUTO Selector Switch
e. Wash 2 HAND/OFF/AUTO Selector Switch
   f. FAULT Light

4. Upstream and Downstream Level Transmitters to be provided for each channel. Refer to Specification 40 72 13 for requirements.

E. Control Panels External Interfaces: Provide for all required signal interfaces between the master control panel, motor starting panels, local control stations, and field devices. Manufacturer to be responsible for accommodating required interfaces between all items.

F. Control Description
   1. In the AUTO mode, each component shall be operated based on the channel water level differential and/or run time.
      a. When the channel water level differential rises to an adjustable preset level the step screens shall begin operating and shall continue to operate until the differential is reduced to the preset normal level. When the channel level drops below the adjustable set point, the screen drive shall stop after an adjustable time delay.
      b. When the screen is operating based on run time, a timer will cycle the screen on and off. The timer range shall be 0 to 60 minutes. The screen shall operate when the timer set point has been reached. The timer shall automatically reset whenever the screen operates.
   2. In the ON mode, each component will operate continuously.
   3. The spray wash will be operated on an adjustable timer.

G. Alarm Control
   1. The following conditions shall shut down the screen system in ON or AUTO mode, sound horn, and illuminate respective pilot light. Alarm silence pushbutton will acknowledge and silence horn; alarm reset will extinguish alarm indicator after condition has been cleared. Any time the alarm reset pushbutton is activated more than twice within 5 minutes of each other, the reset function will be disabled until the alarm is cleared by an operator with supervisor authority.
      a. Screen drive motor overload
   2. The following conditions shall not shutdown the Screen System in ON or AUTO mode, sound horn, and illuminate respective signal. Alarm silence pushbutton will acknowledge and silence horn; alarm reset will extinguish alarm indicator after condition has been cleared.
      a. Channel High-High Level

H. Other Instrumentation and Controls: Provide all items not specifically called out which are required to implement the functions described herein.
2.8 TOOLS AND SPARE PARTS

A. Tools: The work includes one complete set of special tools recommended by the manufacturer for maintenance and repair of each separate type of equipment; tools shall be stored in tool boxes and identified with the equipment number by means of stainless steel or solid plastic name tags attached to the box.

B. Spare Parts:
   1. All equipment shall be furnished with the specified manufacturers spare parts.
   2. Spare parts shall be tagged by project equipment number and identified as to part number, equipment manufacturer, and subassembly component (if appropriate). Spare parts subject to deterioration such as ferrous metal items and electrical components shall be properly protected by lubricants or desiccants and encapsulated in hermetically sealed plastic wrapping. Spare parts with individual weights less than 50 pounds and dimensions less than 2 feet wide, or 18 inches high, or 3 feet in length shall be stored in a wooden box with hinged wooden cover and locking clasp. Hinges shall be strap type. The box shall be painted and identified with stenciled lettering stating the name of the equipment, equipment numbers, and the words "spare parts." A neatly typed and laminated inventory of spare parts shall be taped to the underside of the cover.
   3. Provide, at a minimum, the following spare parts (in total) for the equipment:
      a. One full set of fixed lamella for one screen
      b. One full set of movable lamella for one screen
      c. One full set of intermittent spacers for one screen
      d. Two full set of discharge end spacers
      e. Three full sets of linkage bushings
      f. Two driveshaft bearings
      g. Two excenter bearings
      h. Two (2) Proximity or home position switches
      i. One electric motor
      j. Two grit spray wash solenoid valves

2.9 FABRICATION

A. Shop Assembly: The system shall be factory assembled and tested.

B. Shop/Factory Finishing: Shop prime coatings shall conform to the requirements of Section 09 90 00, PAINTING AND PROTECTIVE COATINGS.

PART 3 - EXECUTION

3.1 GENERAL

A. Coordination shall include space and structural requirements, clearances, utility connections, signals, outputs and features required by the manufacturer including safety interlocks.

3.2 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. Comply with Section 01 60 00, PRODUCT REQUIREMENTS.

B. Delivery of Materials: Products shall be delivered in original, unbroken packages, containers, or bundles bearing the name of the manufacturer.

C. Storage: Products shall be carefully stored in a manner that will prevent damage and in an area that is protected from the elements.
D. Protection of Equipment: Equipment shall be boxed, crated, or otherwise protected from damage and moisture during shipment, handling, and storage. Equipment shall be protected from exposure to corrosive fumes and shall be kept thoroughly dry at all times. Motors, drives, electrical equipment, and other equipment with anti-friction or sleeve bearings shall be stored in weathertight and heated storage facilities prior to installation. For extended storage periods, plastic equipment wrappers shall not be used to prevent accumulation of condensate in gears and bearings.

E. For shipment, exposed surfaces subject to rust, such as mounting flange faces, etc., shall be covered with a rust-preventive compound such as Kendall No. 5, or equal. The equipment shall also be plastic shrink-wrapped for dust protection.

3.3 INSTALLATION

A. As shown on the Drawings. All anchors, bolts, and accessories shall be 316 stainless steel. The manufacturer shall provide templates for anchor bolt locations.

B. Lubricants: Include oil and grease for initial operation.

3.4 FIELD QUALITY CONTROL

A. Functional Testing: Prior to equipment startup, all equipment described herein shall be inspected for proper alignment, quiet operation, proper connection, and satisfactory performance by means of a functional test. Provide certification of test results. Tests and certification shall be as specified in Section 01 79 00, DEMONSTRATION AND TRAINING.

3.5 MANUFACTURER’S SERVICES

A. A manufacturer’s representative for the equipment specified herein shall be present at the job site for the minimum person-days listed for the services hereinafter, travel time excluded:
   1. Installation, Startup, and Testing Services:
      a. 1 person for two, eight-hour days for installation assistance, inspection, and Certificate of Proper Installation.
      b. 1 person for one, eight-hour day for functional and performance testing.
      c. Provide Qualifications of Manufacturer's employee.
   2. Training Services:
      a. 1 person for one, eight-hour day of prestart classroom or jobsite training of Owner’s personnel.
      b. Training of Owner’s personnel shall be at such times and at such locations as required and approved by the Owner.

B. See Section 01 79 00, DEMONSTRATION AND TRAINING of Division 01, GENERAL REQUIREMENTS.

3.6 MANUFACTURER’S CERTIFICATES

A. Provide Manufacturer’s certificate(s). In accordance with Section 01 79 00, DEMONSTRATION AND TRAINING.

3.7 SUPPLEMENTS

A. The supplements listed below, following “END OF SECTION,” are part of this Specification.
   1. Section 46 21 26.1 – Step Screen Drive Data Sheet.
**Section 44 42 27.19: STEP SCREEN SYSTEM**

<table>
<thead>
<tr>
<th>PROJECT:</th>
<th>Western Area WWTP Phase 1 Expansion</th>
</tr>
</thead>
<tbody>
<tr>
<td>OWNER:</td>
<td>City of Huntsville</td>
</tr>
<tr>
<td>EQUIPMENT NAME(S):</td>
<td>Screen Drive Motor #1, #2, #4, #5, #6</td>
</tr>
<tr>
<td>EQUIPMENT TAG NUMBER(S):</td>
<td>10SCR1, 10SCR2, 10SCR3, 10SCR4</td>
</tr>
<tr>
<td>CONTROL PANEL(S):</td>
<td>See on Drawings</td>
</tr>
</tbody>
</table>

**MOTOR DATA**

<table>
<thead>
<tr>
<th>Type:</th>
<th>Squirrel-cage induction meeting requirements of NEMA MG1.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Manufacturer:</td>
<td>For multiple units of the same type of equipment, furnish motors and accessories of a single manufacturer.</td>
</tr>
<tr>
<td>Hazardous Location:</td>
<td>Furnish motors for hazardous (classified) locations that conform to UL 674 and have an applied UL listing marking.</td>
</tr>
<tr>
<td>Motor Horsepower:</td>
<td>1.5 (max)</td>
</tr>
<tr>
<td>Enclosure Type:</td>
<td>TEFC</td>
</tr>
<tr>
<td>Voltage:</td>
<td>230/460</td>
</tr>
<tr>
<td>Material:</td>
<td>Cast Iron; A48 Class 35B</td>
</tr>
<tr>
<td>Phase:</td>
<td>3</td>
</tr>
<tr>
<td>Mounting Type:</td>
<td>Horizontal  Vertical</td>
</tr>
<tr>
<td>Frequency:</td>
<td>60</td>
</tr>
<tr>
<td>Load Class:</td>
<td>Constant Torque</td>
</tr>
<tr>
<td>Synchronous Speed:</td>
<td>1,800 rpm</td>
</tr>
<tr>
<td>Multispeed, Two Speed:</td>
<td>rpm</td>
</tr>
<tr>
<td>Winding:</td>
<td>One  Two  Thermal protection embedded in windings  Service Factor: 1.0  1.15</td>
</tr>
<tr>
<td>Motor nameplate horsepower shall not be exceeded at any operational point.</td>
<td></td>
</tr>
<tr>
<td>Additional Motor Requirements:</td>
<td>See Section 26 05 15, ELECTRIC MOTORS</td>
</tr>
<tr>
<td>Provide:</td>
<td>Space Heater  Oversize main terminal (conduit) box for motors  Moisture Detection Switches</td>
</tr>
</tbody>
</table>

**SPECIAL FEATURES / NOTES**
SECTION 46 21 60 - WATER SLUICE SYSTEM

PART 1 - GENERAL

1.1 SUMMARY

A. This section includes the Work necessary to completely furnish and install the water sluice system, including all related equipment, material, and appurtenances as shown on the drawings and specified herein.

B. Equipment Specified within the following sections shall be coordinated and supplied by a single manufacturer:
   1. Section 44 42 27.20 – Screenings Washer Compactor
   2. Section 46 21 26 – Step Screen
   3. Section 46 21 60 – Water Sluice System

1.2 COSTS OF PRE-NEGOTIATED ITEMS

A. Owner has entered into a pre-negotiated cost agreement with the specified manufacturer for some items in this section of the specification. Refer to Attachment "A" BID FORM for more details. The pre-negotiated cost agreement and proposal from the specified manufacturer is provided as an attachment to this specification section. The Contractor shall carefully review the pre-negotiated proposal and scope of supply to determine those items required by the Contract Documents which are not part of the proposal or specified manufacturer’s scope of supply. In addition to the pre-negotiated costs indicated in Attachment “A” BID FORM, the Contractor shall include in the Lump Sum Bid Price the costs for the following:
   1. All items not specifically itemized in the manufacturer’s scope of supply provided as part of the pre-negotiated proposal but required by the Contract Documents and/or necessary to provide a complete and operational system.
   2. All items specifically itemized in the manufacturer’s scope of supply provided as part of the pre-negotiated proposal which are designated to be provided by others, provided by the customer, provided by the Owner, or any similar designation.
   3. All labor, materials, and all other associated costs not included in the pre-negotiated proposal but required by the Contract Documents and required to provide a complete and operational system.

1.3 GENERAL

A. Like items of equipment provided hereinafter shall be the end products of one manufacturer to achieve standardization of appearance, operation, maintenance, spare parts and manufacturer’s services.

B. Unit Responsibility: The Work requires that the water sluice system, local control panel, instruments, and components complete with all accessories and appurtenances be the end product of one responsible system manufacturer or responsible system supplier. Unless otherwise indicated, the Contractor shall obtain each system from the responsible supplier of the equipment. The supplier shall furnish all components and accessories of the system to enhance compatibility, ease of operation and maintenance, and as necessary to place the equipment in operation in conformance with the specified performance, features, and functions without altering or modifying the Contractor's responsibilities under the Contract Documents. The Contractor is responsible to the Owner for providing the equipment systems as specified herein and in the pre-negotiated agreement which is provided as an attachment to this specification section.
C. General Requirements: See Division 01, GENERAL REQUIREMENTS, which contains information and requirements that apply to the work specified herein and are mandatory for this project.

1.4 SUBMITTALS

A. General: Administrative, shop drawings, samples, quality control, and contract closeout submittals shall conform to the requirements of Section 01 33 00, SUBMITTAL PROCEDURES.

B. In addition to the requirements of Section 01 33 00, SUBMITTAL PROCEDURES, submit the following additional specific information:

1. Shop Drawings:
   a. Make, model, weight, and horsepower of each component.
   b. Manufacturer's catalog information, descriptive literature, specifications, and identification of materials of construction.
   c. Detailed mechanical, and electrical drawings showing the equipment fabrications and interface with other items. Include dimensions, size, and details of anchorage and of connections to other work, and weights of associated equipment.
   d. Gear output torque and screen lifting capacity calculations
   e. External utility requirements (quantity and connection details) such as air, water, power, drain etc., for each component.
   f. Motor nameplate data, motor manufacturer, and any motor modifications.
   g. Wiring diagrams for motors, including terminals and numbers.
   h. Suggested spare parts list to maintain the equipment in service for a period of 1 year and 5 years. Include a list of special tools required for checking, testing, parts replacement, and maintenance with current price information.
   i. List of special tools, materials, and supplies furnished with equipment for use prior to and during startup and for future maintenance.
   j. Instrumentation and Control Submittals: In conformance with Division 40.
   k. Provide complete headloss calculation sheets and outputs, including peak and average flow scenarios, with 10%, 30%, 50%, and 70% blinded conditions.

2. Quality Control Submittals:
   a. Manufacturer's Certificate of Compliance: Commercial products, including painting/coating systems.
   b. Special shipping, storage and protection, and handling instructions.
   c. Test procedures.
   d. Test results, reports, and certifications.
   e. Manufacturer's Certificate of Proper Installation.
   f. Operation and maintenance manual.


1.5 QUALITY CONTROL

A. The materials covered under these specifications are intended to be standard equipment of proven reliability and as manufactured by a reputable manufacturer having experience in the production of screening equipment. The equipment furnished shall be designed and constructed in accordance with the best practices and methods and shall operate satisfactorily when installed as shown on the Contract Drawings and operated per the manufacturer's recommendations.

B. Fabrication shall be done in compliance with all applicable ASTM standards or equivalent international standards.
1.6 OPERATION AND MAINTENANCE DATA
   A. O&M Manuals: Content, format, and schedule for providing as specified in Section 01 78 23, OPERATION AND MAINTENANCE DATA.
   B. Maintenance Summary Forms: As specified in Section 01 78 23, OPERATION AND MAINTENANCE DATA.

1.7 WARRANTY
   A. Provide warranty for a period of 12 months at the date of startup of the equipment. The warranty shall stipulate that the equipment furnished is suitable for the purpose intended and free from defects of material and workmanship for the duration of the warranty. In the event the equipment fails to perform as specified, the Manufacturer will promptly repair or replace the defective equipment without additional cost to the Owner.
   B. Spare parts identified within this specification shall not be used to address warranty repairs.

PART 2 - PRODUCTS

2.1 MANUFACTURERS
   A. Where a manufacturer's standard equipment name and/or model number is listed, the equipment system shall be provided and modified as required to conform to the performance, functions, features, and materials of construction as specified herein.
   B. Materials, equipment, components, and accessories specified in this section shall be, products of:
      1. Huber Technology, Inc.

2.2 GENERAL REQUIREMENTS
   A. Manufacturer shall provide required number and size of anchor bolts for each system.
   B. Stainless Steel: Stainless steel components shall be 304 stainless steel, or higher, as specified.
   C. Nameplates: Equipment nameplates of stainless steel shall be engraved or stamped and fastened to the equipment in accessible locations with stainless steel screws or drive pins. Nameplates shall contain the manufacturer's name, model, serial number, size, characteristics, and appropriate data describing the machine performance ratings.

2.3 SERVICE CONDITIONS
   A. The water sluice system shall receive screenings from the 6 mm fine screens. The water sluice trough system shall convey the screens to the screenings washing and compacting equipment that shall wash, compact and dewater the screenings and deposit them into a dumpster.
   B. The water sluice system shall be designed to sit flush with the tops of the channels as indicated in the drawings. The trough shall be sloped to the screenings washing and compacting equipment.
   C. Knife gate valves shall be installed at the discharge location of the water sluice system into the screenings washing and compacting equipment.
D. All equipment specified herein is intended to be standard equipment for conveying raw sewage screenings, including rags, plastic, and other debris to the screenings washing and compacting equipment.

2.4 SYSTEM PERFORMANCE AND FUNCTIONAL REQUIREMENTS

A. Design Criteria:
1. Number of Units: One (1)
2. Trough Width (Screen level): 14-inch
3. Trough Width (Lower level): 14-inch
4. Min. Trough Material Thickness, inch: 10 gauge
5. Max. sluice water requirement per unit, gpm: 200
6. Min. sluice water pressure required, psi: 45
7. Sluice water valve diameter, inches: 6
8. Knife gate valve diameter, inches: 14

2.5 EQUIPMENT AND/OR MATERIALS

A. Unless otherwise specified in these specifications, the entire equipment shall be manufactured from AISI 316 stainless steel shapes (rods, angles, and channels), pipes, and sheets. All mechanical parts shall be designed to handle the forces that may be exerted on the equipment during fabrication, shipping, erection, and proper operation.

B. Sluice Trough
1. The sluice trough shall be U-shaped, fabricated from 316 stainless steel plate. The inside of the sluice trough shall be smooth and shall not allow locations for debris to collect while being conveyed. The screen level trough shall have external flanges at the top to facilitate cover attachment to concrete surfaces.
2. The sluice trough shall be equipped with inlet, drain, overflow, overflow notch at the upper level, level instruments, and other connections, as indicated on the drawings.
3. The top of the U-trough at the lower level shall be furnished with cover panels hinged to the sluice trough and shall be provided with a minimum of two hasps to hold the panels in place. The cover panels shall have a minimum thickness of 20-gauge and be constructed of 316 stainless steel. Provide a handle on top of the cover panel to open it periodically for observation and maintenance purpose. The weight of the sluice cover panel shall be no more than 50-lbs per OSHA requirement to enable a single person to lift the panel easily. Hinges shall allow greater than 90-degree opening so that the panel can be self-supporting when fully open and also remain reachable for closure from the platform side.
4. The trough head plate shall be provided with 3-inch NPT electric actuated ball valve for connection of the sluice water source.
5. The sluice water connection to the water sluice shall be made either from the bottom of the sluice or from the side as preferred by the manufacturer.
6. Electric actuated ball valve(s) located within the hazardous location shall be rated for Class 1, Div. 2.
7. All welds on 316 stainless steel parts are to only use 316 stainless steel weld filler media to prevent bimetallic corrosion.

2.6 ELECTRICAL COMPONENTS AND ACCESSORIES

A. General:
1. Conform with Division 26, ELECTRICAL and Division 40, Instrumentation.
2. Provide all necessary electrical components and wiring for a complete, functional system.

B. Wiring: The Drawings and Specifications indicate the anticipated wiring for the equipment provided under this section. If additional wiring is required, or if required wiring does not match what is indicated, the Manufacturer shall make the necessary modifications to the electrical wiring.
and documentation as part of the lump sum price. Wiring shall meet the requirements of Division 26, Division 40, and NFPA 70. Insulation shall be rated 600 volts, minimum. Low-voltage (24V) signals shall be run in twisted, shielded pair cable.

C. Electrical Raceways: Electrical wiring shall be installed in conduit meeting the requirements of Division 26, ELECTRICAL.

D. Motors:
   1. Provide squirrel-cage AC induction motors meeting the requirements of Division 26, and as specified herein.
   2. For additional specific requirements on motors, refer to the Motor Data table above.

2.7 INSTRUMENTATION AND CONTROLS

A. All instrumentation and control components shall be provided in accordance with the requirements of Division 40, ELECTRICAL.

B. All controls necessary for the fully automatic operation of the sluiceway shall be provided. The controls shall be designed to ensure sufficient protection to prevent equipment damage.

C. Refer to Specification Section 46 21 26 Step Screens for control panel requirements of the complete screening system, including the Water Sluice System.

D. Control of the water sluice system shall be made by the screening system Master Control Panel.

E. Water Sluice Trough System Operation and Controls:
   1. The motorized sluice water ball valve actuator shall be provided with an integral HAND/OFF/AUTO selector switch and OPEN/CLOSE pushbuttons.
   2. When the sluice water ball valve is in the AUTO position, the valve shall OPEN when any of the screens discharging to the sluice are selected for Auto or ON position. The screens shall delay 15 seconds (field adjusted) prior to start to allow sluice water to fill the trough. The motorized ball valve shall remain open until all the screens being served by the sluice are switched to OFF mode. The motorized ball valve shall close with a 15 seconds time delay (field adjusted) after the all the screens are indicated to turn OFF to allow complete sweep of screenings from the water sluice.

2.8 TOOLS AND SPARE PARTS

A. Tools: The work includes one complete set of special tools recommended by the manufacturer for maintenance and repair of each separate type of equipment; tools shall be stored in tool boxes, and identified with the equipment number by means of stainless steel or solid plastic name tags attached to the box.

B. Spare Parts:
   1. Spare parts shall be tagged by project equipment number and identified as to part number, equipment manufacturer, and subassembly component (if appropriate). Spare parts subject to deterioration such as ferrous metal items and electrical components shall be properly protected by lubricants or desiccants and encapsulated in hermetically sealed plastic wrapping. Spare parts with individual weights less than 50 pounds and dimensions less than 2 feet wide, or 18 inches high, or 3 feet in length shall be stored in a wooden box with hinged wooden cover and locking clasp. Hinges shall be strap type. The box shall be painted and identified with stenciled lettering stating the name of the equipment, equipment numbers, and the words “spare parts.” A neatly typed inventory of spare parts shall be taped to the underside of the cover.
   2. Provide, at a minimum, the following spare parts for the equipment:
a. One (1) motorized ball valve for sluice water connection.

PART 3 - EXECUTION

3.1 GENERAL

A. Coordination shall include space and structural requirements, clearances, utility connections, signals, outputs and features required by the manufacturer including safety interlocks.

3.2 ASSEMBLY AND PREPARATION FOR SHIPMENT

A. Each drive unit, including motor, shall be completely factory assembled, aligned, and securely crated for shipment. Accessory equipment which cannot be shipped assembled to the unit, such as shafts, baseplates, impellers, spare parts, and anchorage materials, shall be separately crated, clearly marked as to the contents, and shipped on the same shipment as the drives.

B. For shipment, exposed surfaces subject to rust, such as mounting flange faces, etc., shall be covered with a rust-preventive compound such as Kendall No. 5, or equal.

3.3 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. Delivery of Materials: Products shall be delivered in original, unbroken packages, containers, or bundles bearing the name of the manufacturer.

B. Protection of Equipment: Equipment shall be boxed, crated, or otherwise protected from damage and moisture during shipment and handling. Equipment shall be protected from exposure to corrosive fumes and shall be kept thoroughly dry at all times. Pumps, motors, drives, electrical equipment, and other equipment with anti-friction or sleeve bearings shall be stored in weathertight and heated storage facilities prior to installation. For extended storage periods, plastic equipment wrappers shall not be used to prevent accumulation of condensate in gears and bearings.

3.4 FIELD QUALITY CONTROL

A. Upon completion of installation of the equipment, an acceptance test shall be conducted to verify the satisfactory operation of each system. The test shall be conducted in a manner approved by and in the presence of the Owner and Engineer for both normal and overflow scenarios. The unit shall be checked for, vibration, alignment, leaking, general operation, etc. The unit must perform in a manner acceptable to the Owner and Engineer before final acceptance.

3.5 INSTALLATION

A. Install the equipment in strict accordance with the respective manufacturer’s instructions and recommendations. Provide a letter of certification of installation from manufacturer. Anchor bolts shall be furnished by the equipment manufacturer and set by the Contractor in accordance with the manufacturer’s recommendations.

3.6 MANUFACTURER’S SERVICES

A. A manufacturer’s representative for the equipment specified herein shall be present at the job site for the minimum person-days listed for the services hereunder, travel time excluded:

1. Installation, Startup, and Testing Services:
   a. 1 person-days for installation assistance, inspection, and Certificate of Proper Installation.
   b. 1 person-day for functional and performance testing.
c. Provide Qualifications of Manufacturer's Representative.

2. Training Services:
   a. 1 person-day of prestart classroom or jobsite training of Owner’s personnel.
   b. Training of Owner’s personnel shall be at such times and at such locations as required and approved by the Owner.
   c. Training shall only be conducted after Engineer/Owner acceptance of the Operations and Maintenance Manuals. These manuals shall be provided to staff on, or before, date of training.

3.7 MANUFACTURER'S CERTIFICATES

   A. Provide Manufacturer’s certificate(s). In accordance with Section 01 79 00, DEMONSTRATION AND TRAINING.

END OF SECTION