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K. Variable Frequency Drives (VFD)

1. References
   a. The VFD controller shall meet or exceed the requirements within the following standards for VFDs.
      1) NFPA 70
      2) UL 508C
      3) NEMA ICS 3.1
      4) NEMA 250
      5) IEEE 519

      IEEE 519 Reference Table

      NOTE: Vendor to provide harmonic analysis study as part of submittal process to ensure provided equipment is in compliance with this standard.

      Harmonic Current Distortion Limits (I_h and TDD) in % of I_L ($\leq$ 69kV)

I_{SC}/I_L Ratio	I_h <11	11≤ I_h <17	17≤ I_h <23	23≤ I_h <35	TDD
<20	4.0	2.0	1.5	0.6	5.0
20-50	7.0	3.5	2.5	1.0	8.0
50-100	10.0	4.5	4.0	1.5	12.0
100-1000	12.0	5.5	5.0	2.0	15.0
>1000	15.0	7.0	6.0	2.5	20.0

      The voltage distortion guidelines for IEEE-1992 (at 480V) remain the same as IEEE 519-1981:

      3% - Special systems (i.e. hospitals or universities)
      5% - General systems
      10% - Dedicated systems (AFD's only)

      NOTE: The point of analysis shall be the secondary side of the utility transformer. (480V)
2. Design Requirements
   a. Provide VFD controllers in accordance with the detailed specifications and plans.
3. Submittals
   a. Shop drawings are required with the following:
      1) Fault ratings.
      2) Unit descriptions, including amperage ratings, circuit breaker frame sizes, circuit breaker continuous amp ratings, pilot devices, etc.
      3) Schematic wiring diagrams.
4. Warranty
   a. The VFD manufacturer shall provide a Parts and Labor warranty for the VFDs that extends 24 months from the date of start-up or 18 months from the date of Project Acceptance, whichever expires first.
5. Manufacturers
   a. Square D Altivar 61
   b. Eaton SVX9000
   c. Danfoss VLT Aqua

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d. GE AF-650

6. Ratings
   a. Voltage: Unless shown differently on the plans, the VFD shall be rated for a 480V (+/- 10%), 3-phase system.
   b. For VFD controllers greater than 5HP, the displacement power factor shall range between 1.0 and 0.95 lagging, over the entire speed range.
   c. Efficiency: Minimum of 97% at full load and speed.
   d. Environmental Ratings:
      1) Operating ambient temperature range (NEMA 4X): 0° C to 40° C.
      2) Relative humidity range: 5% to 95% non condensing.
   e. Output Power Ratings:
      1) The output voltage shall be adjustable from 0 to rated motor voltage.
      2) The output frequency range shall be adjustable from 0 to 320 Hz.
      3) The inverter section shall produce a pulse-width-modulated (PWM) waveform using latest generation insulated gate bipolar transistors (IGBTs).
   f. Sizing:
      1) Unless otherwise noted on the plans, all loads are normal-duty loads.
      2) The VFD manufacturer shall size each VFD based on the following normal-duty requirements:
         i. VFD continuous output amps rating shall be higher than the Full Load Amps (FLA) of the motor that it is to control.
         ii. VFD 1-minute overload output amps rating shall be a minimum of 110% higher than the FLA of the motor that it is to control.
         iii. VFD 3-second overload output amps rating shall be a minimum of 150% higher than the FLA of the motor that it is to control.
7. Enclosure
   a. The VFD shall be mounted within the motor control center.
8. VFD Controller Features
   a. Overload Protection
      1) The drive shall provide internal Class 10 motor overload protection investigated by UL to comply with N.E.C. Article 430.
      2) Overload protection shall be speed sensitive and adjustable.
   b. Terminal Blocks
      1) Separate terminal blocks shall be provided for control and power wiring.
   c. Flying Start
      1) The drive shall be capable of determining the speed and direction of a spinning motor and adjust its output to “pick up” the motor at the rotating speed.
9. VFD System Options
   a. Harmonic Mitigation
   b. High System Harmonic Influence VFD Controllers shall be provided with 3% line reactors and passive filters (IEEE 519 – 1992 compliant):

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1) Other harmonic mitigation designs, including Active Filters and Active Front Ends, are not allowed.

c. Hand-Off-Auto Selector Switch
   1) Provide a “Hand/Off/Auto” selector switch for start-stop control.
   2) Provide pilot lights for indication of the “Hand” and “Auto” modes.
   3) The devices shall be NEMA Type 4/4X/12 (minimum 22.5mm diameter), mounted on the drive system enclosure door.

d. Pilot Lights
   1) Provide pilot lights, mounted on the enclosure door, for indication of Control Power On, Run, and Drive Fault (others if indicated on the plan drawings).
   2) The devices shall be NEMA Type 4/4X/12 (minimum 22.5mm diameter), mounted on the drive system enclosure door.

e. Speed Potentiometer
   1) Provide a NEMA Type 1/4/12 single turn speed pot mounted on the drive system enclosure door.

f. Communications
   1) Provide Ethernet/IP communications for remote control from SCADA.

10. Manufacturer’s Services
    a. The VFD Manufacturer shall provide start-up services for the VFDs. The start-up services shall be performed by a trained Field Service Engineer who is an employee of the VFD manufacturer and a degreed engineer. All costs (travel, expenses, potential stand-by time) shall be included in the start-up services. The VFD manufacturer shall be responsible for coordinating with the Equipment Supplier and Installer to avoid/minimize stand-by time. Per VFD, a minimum of 4 hours on-site service shall apply for VFDs rated 77A or below. Per VFD, a minimum of 6 hours on-site service shall apply for VFDs rated above 77A.
    b. At a minimum, the start-up service shall include:
       1) Pre-Power Check
          i. Megger motor resistances: phase-to-phase and phase-to-ground.
          ii. Verify system grounding per manufacturer’s specifications.
          iii. Verify power and ground signals.
          iv. Check connections.
          v. Check environment.
       2) Power-Up and Commissioning
          i. Measure incoming power: phase-to-phase and phase-to-ground.
          ii. Measure DC bus voltage.
          iii. Measure AC current: unloaded and loaded.
          iv. Measure output voltage: phase-to-phase and phase-to-ground.
       3) Record all measurements.
       4) Tune for system operation.
       5) Provide final parameter listing.

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11. Training
    a. The VFD manufacturer shall provide (1) 6-hour on-site training course for up to 6 students on the basic operation, maintenance, and troubleshooting of the VFDs and reduced voltage solid state starters utilized on the project. If VFDs are supplied in a combination of Specification Sections by different Equipment Suppliers, then only one VFD training session is required. This training will be conducted on (1) trip. Coordination shall be the responsibility of the Equipment Suppliers. All costs (travel and expenses) shall be included.
    b. At a minimum, the training shall include:
        1) Review of the final plans identifying major components.
        2) Review starting/stopping procedures and options for the various controllers/starters.
        3) Review operation of the Human Interface Modules (if applicable for programming and monitoring of the system(s).
        4) Review the maintenance requirements of the system(s).
        5) Review safety concerns of the system(s).
        6) Hands-On Labs (max two students per VFD demo).
        7) Review of Support Sources and contacts

2.05 AUXILIARY EQUIPMENT

A. Identification:

1. The motor control center, each magnetic starter, each feeder protective device, and each auxiliary equipment item shall be provided with an engraved plastic nameplate approximately 1" x 3" permanently attached to the unit exterior door with self-tapping screws. Refer to ELECTRICAL IDENTIFICATION section.
2. Refer to the basic electrical requirements section of these specifications for nameplate requirements.
3. Submit complete schedule with the shop drawings listing all nameplates and information thereon.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install motor control center on 3" high concrete pad, the horizontal dimensions of which shall exceed the base dimensions of the motor control center by 3" on all sides.

B. Control and power circuits shall terminate in respective section in which starter is located.

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C. Lace and group conductors installed in motor control center with nylon tie straps. Only one conductor shall be installed under each terminal. Form and train conductors in enclosure neatly parallel and at right angles to sides of box. Uninsulated conductor shall not extend beyond one-eighth inch from terminal lug.

D. Do not splice conductors in motor control center. Where required, installed junction box adjacent to enclosure and splice or tap conductors in box. Refer to number of conductors in a conduit limitation defined in the wires and cables section section of the specifications and do not exceed.

E. Conductors not terminating in motor control center section or unit shall not extend through or enter the section or unit.

F. Maintain conductor phase color code requirement described in the wires and cables section of the specifications.

3.02 CLEANING AND ADJUSTMENT

A. After completion, clean the interior and exterior of dirt, paint and construction debris.

B. Touch up paint all scratched or marred surfaces with factory furnished touch up paint of the same color as the factory applied paint.

C. Select and install overload heaters based on the full load current of the motor actually installed.

3.03 IDENTIFICATION

A. Refer to the ELECTRICAL IDENTIFICATION section of these specifications for identification requirements.

3.04 FIELD QUALITY CONTROL

A. Refer to the ELECTRICAL EQUIPMENT ACCEPTANCE TESTING section of this specification.

B. Contractor shall verify in the field that all factory-made connections and terminations are torqued to manufacturer's recommended tolerances.

END OF SECTION

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DIVISION 26 – ELECTRICAL

262726 – WIRING DEVICES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. The work included under this section of the specifications consists of the installation of wiring devices, i.e. switches and receptacles and device plates. All materials shall be provided under this section of the specifications.

B. Select devices from lists of acceptable devices contained in this section of the specifications.

C. The catalog numbers listed herein for switches and receptacles are for items with brown finish. Notwithstanding catalog numbers, the switches and receptacles provided on this project shall have white finish unless otherwise indicated. All special purpose receptacles shall be provided in black finish.

1.03 QUALITY ASSURANCE

A. NEMA WD-1 General Purpose Wiring

B. NEMA WD-5 Specific Purpose Wiring Devices

PART 2 - PRODUCTS

2.01 SWITCHES

A. Select switches from the following:

1. Single pole, 20 amp 277 volt switch: Arrow Hart 1991, Hubbell 1221, Leviton 53521, Pass & Seymour 20AC1.
2. Threeway, 20 amp 277 volt switch: Arrow Hart 1993, Hubbell 1223, Leviton 53523, Pass & Seymour 20AC3.
3. Four way, 20 amp 277 volt switch: Arrow Hart 1994, Hubbell 1224, Leviton 53524, Pass & Seymour 20AC4.
4. Weatherproof, 20 amp 277 volt switch: Arrow Hart 2991-2881G, Hubbell 1281-1750, Pass & Seymour 22515-4515.

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5. Weatherproof, 20 amp 277 volt three way switch: Arrow Hart 2993/2881-G, Hubbell 1283-1750, Pass & Seymour 22535-4515.
6. Single pole, 20 amp 120 volt switch with pilot lamp in handle: Arrow Hart 2999-R, Hubbell 1221 PL.
7. Single pole 20 amp 277 volt switch with pilot lamp in handle: Arrow Hart 2999-I-277, Hubbell 1221-PL7.

2.02 RECEPTACLES

A. Select receptacles from those listed herein. Designation in parenthesis is NEMA configuration required.

1. 15 amp, 125 volt grounded duplex receptacle (5-15R): Arrow Hart 5262, Hubbell 5262, Leviton 5262, Pass & Seymour 5262.
2. 20 amp, 125 volt grounded duplex receptacle (5-20R): Arrow Hart 5739, Hubbell 5362, Leviton 5362.
3. Ground Fault Interrupter (GFI) 15 amp, 125 volt duplex receptacle: Leviton 6194, Arrow Hart 1591, Hubbell GF-5262, Pass & Seymour 1591-F.
4. Ground Fault Interrupter (GFI), 15 amp 125 volt duplex receptacle, through feed type: Arrow Hart 1591-F, Leviton 6399, Pass & Seymour 1591-F, Hubbell GF-5262.
5. Transient Voltage Surge Suppression (TVSS) receptacles shall comply with ANSI/IEEE C62.41 and LILI449 (July 1987) for categories A and B. Devices shall provide RFI and EMI noise filtration of not less than a 7:1 reduction. Devices shall suppress transients in each of 3 modes: Line-to-neutral, line-to-ground, and neutral-to-ground. Devices shall be provided with an LED for positive indication of failure of protective circuitry or audible alarm. Products complying with this specification manufactured by Arrow Hart, Hubbell, Leviton, or Pass and Seymour are acceptable.

2.03 DEVICE PLATES

A. Device plates shall be one piece single or multi-gang type selected to match the device or combination of devices. Device plates for flush mounted devices shall be type 302 stainless steel unless indicated otherwise.

1. Device plates for use with devices flush mounted in exposed masonry construction shall be jumbo type. Device plates for surface mounted devices shall be for use with the type of outlet box in which the device is mounted. All devices installed in areas exposed to the weather and where indicated on the drawings shall be provided with a weatherproof device plate.
2. Where engraved device plates are indicated on the drawings or specified in Division 16, engraving shall be done by the device plate manufacturer. All lettering shall be 1/8" high and shall be black unless other contrasting color is specified.

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PART 3 - EXECUTION

3.01 GENERAL INSTALLATION

A. The mounting height of devices are indicated in the legend on the drawings and is intended to mean the bottom of the device above the finished floor unless otherwise indicated on the drawings. Where finished walls are exposed concrete block, brick or tile, the height shall be adjusted to allow outlet box for device to be mounted at a joint.

B. Review Engineering Drawings for any device requiring specific location. Install receptacles above countertops with major axis horizontal above the backsplash.

C. Mount all devices within outlet boxes to allow device plates to be in contact with wall on all sides. Align devices with major axis of device parallel to adjacent predominate building feature, i.e., doorframes or countertops.

D. Install wall switches on the strike side of doors.

END OF SECTION

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DIVISION 26 – ELECTRICAL

262816 – CIRCUIT AND MOTOR DISCONNECTS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. This section covers disconnect switches for electrical equipment, 600V and below, and fuses mounted in the disconnect devices.

B. Furnish and install disconnect switches for any of the following conditions:

1. Where indicated on the drawings.
2. For all motors located out-of-sight of its motor controller.
3. For water heaters.
4. For electrical unit heaters.
5. Where required by the National Electrical Code.

1.03 QUALITY ASSURANCE

A. Referenced Industry Standard: The following specifications and standards are incorporated into and become a part of this Specification by reference.

1. Underwriters' Laboratories, Inc. (UL) Publications:
   a. No. 98: Enclosed Switches
   b. No. 198.2: High-Interrupting Capacity Fuses, Current Limiting Type
   c. No. 198.4: Class R fuses
2. National Fire Protection Association (NFPA) Publications:
   a. No. 70: National Electrical Code (NEC)
3. National Electrical Manufacturers Association (NEMA) Publications:
   a. No. KS 1: Enclosed Switches
4. Federal Specification (Fed Spec):
   a. No. WS-865-C

B. Acceptable Manufacturers: Products of the following manufacturers, which comply with these specifications, are acceptable:

1. General Electric
2. Eaton
3. Square D

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C. Coordination: Coordinate installations with architectural and structural features, equipment installed under other sections of the specifications and electrical equipment to insure disconnect switch access and insure that clearance minimums are provided.

PART 2 - PRODUCTS

2.01 GENERAL MATERIAL REQUIREMENTS

A. Furnish all materials specified herein.

B. All disconnects and fuses shall be UL listed and bear a UL label.

C. Fuses shall be heavy duty, type HD horsepower rated as required for motor load served.

D. Switches shall be 600 volt rated, except for use in system below 240 volt, when they may be 250 volt rated. Switches shall be heavy duty rated. General duty switches are not acceptable.

E. Furnish a solid neutral for each switch being installed in a circuit which includes a neutral conductor.

F. Furnish an equipment grounding conductor lug bonded to the switch enclosure.

G. Disconnect switches shall be non-fusible safety switch, unless fused type is specified or indicated on the drawings, with the number of poles required to disconnect all ungrounded conductors serving equipment.

H. Enclosure shall be NEMA Type One in all interior dry locations and shall be NEMA Type 4X stainless steel in all damp, wet, or exterior locations, unless other type is indicated on the drawings or specified herein.

2.02 PRODUCT/MATERIAL DESCRIPTION

A. Switching mechanism shall be quick-make, quick-break type.

B. Where non-fused disconnect switches are indicated on the drawings or specified for use as disconnects, they shall be the non-fused type.

C. Switches shall have the following features:

1. Provide line terminal shields in all switches.
2. Each switch shall have provisions for padlocking in the "OFF" position.
3. Each switch shall have door interlocks to prevent door from being opened when switch is in closed position. Provide inconspicuous means to defeat interlock mechanism.

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4. Provide permanent nameplate indicating switch rating in voltage, amperes and horsepower.
5. Arch chute for each pole.
6. Provide auxillary contacts (break-first/make-last) for VFD driven motors.

D. Disconnect switches for three phase motors rated two horsepower and above shall be three pole nonfusible type rated as indicated on the drawings. Disconnect switches for three phase motors rated below two horsepower shall be three pole manual motor starter switches without overload protection. Disconnect for single phase motors shall be single or two pole horsepower rated switches without overload protection.

E. Fusible switches through 600 amp shall be provided with rejection clips to accept RK1 or RK5 class fuses only. Fusible switches larger than 600 amp shall be suitable for class L fuses. Furnish and install a complete set of fuses in each disconnect sized as indicated on the drawings. Fuses serving predominantly motor or transformer loads shall be dual-element, time delay type, otherwise non-time delay fast acting type is required. Fuses shall be current limiting with 200,000 AIC.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Locate disconnect switches to maintain line of sight and to provide working clearance and full accessibility as required by the National Electrical Code.

B. Unless indicated otherwise on the drawings, locate disconnects adjacent to equipment served.

C. Lace and group conductors installed in disconnect with nylon tie straps. Only one conductor shall be installed under terminals. Form and train conductors in enclosure neatly parallel and at right angles to sides of box. Uninsulated conductor shall not extend beyond 1/8" from terminal lug.

D. Mounting and Support

1. Enclosure shall be secured to structure by a minimum of four (4) fastening devices. A 1.5" minimum diameter round washer shall be used between head of screw or bolt and enclosure.
2. Mounting
   a. Enclosures shall be mounted where indicated on the drawings or specified herein. Support from the structure with fastening device specified.
   b. Attach enclosure directly to masonry, concrete, or wood surfaces.
   c. Mount enclosure on metal channel (strut), which is connected to structure with fastening device specified, for installations on steel structure, sheet metal equipment enclosure, or sheet rock walls.

d. Where enclosure is not indicated on a wall or structure, construct a metal channel (strut) free standing frame secured to floor, pad, or other appropriate building structure. Refer to the detail on the drawing for frame installation and construction information.
e. Mount switch with handle between 36" and 60" above floor or grade, unless otherwise indicated on the drawings.

E. Do not splice conductors in enclosure. Where required, install junction box or wireway adjacent to disconnect and splice or tap conductors in box. Refer to number of conductors in a conduit limitation defined in the WIRES AND CABLES section of the specifications and do not exceed.

F. Conductors not terminating in disconnect shall not extend through or enter disconnect enclosure.

G. Install push-in knock-out closure plugs in any unused knock-out openings (NEMA1). Provide Hoffman Hole-Seal in NEMA 4X switches.

H. Identification

1. Disconnect switches shall be identified.
2. Refer to the ELECTRICAL IDENTIFICATION section of the specifications for identification requirements.

3.02 CLEANING AND ADJUSTMENT

A. After completion, clean the interior and exterior of dirt, paint and construction debris.

B. Touch up paint all scratched or marred surfaces with factory furnished touch up paint of the same color as the factory applied paint.

END OF SECTION

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DIVISION 26 – ELECTRICAL

262913 – MOTOR CONTROLLERS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. The work required under this section of the specifications consists of the installation of motor controllers for all integral or fractional horsepower motors not controlled by magnetic starters installed in motor control center or by magnetic starters provided as an integral component of a specific piece of equipment. Provide all material under this section of the specifications.

1.03 QUALITY ASSURANCE

A. ANSI/NEMA Standards Publication ICS 1 - General Standards for Industrial Control and Systems.

B. ANSI/NEMA Standards Publication ICS 2 - Standards for Industrial Control Devices, Controllers and Assemblies.

C. UL 508 Standards for Industrial Control Devices, Controllers and Assemblies - Industrial Control Equipment.

1.04 ACCEPTABLE MANUFACTURERS

A. The products of General Electric, Square D, or Eaton conforming to these specifications are acceptable.

PART 2- PRODUCTS

2.01 MAGNETIC STARTERS

A. Magnetic starters shall be across-the-line circuit breaker combination type non-fusible disconnect combination type when remotely located from circuit breaker in panel or switchboard; otherwise magnetic starters shall be non-combination type. Where circuit breaker type are used, UL interrupting rating of circuit breaker shall not be less than the rating of the overcurrent device immediately upstream.

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B. Magnetic starters shall be NEMA size one unless other size is shown on the drawings or unless larger size is required by actual motor controlled. Enclosures shall be NEMA one unless otherwise shown on the drawings or specified in this section of the specifications. Starters shall be for operation at the voltage and phase arrangement indicated.

C. Each magnetic starter shall have overload relays in each phase leg. Control voltage shall be 120 volts provided from a control power transformer built into starter. Provide fuse for control coil. Provide Hand-Off-Automatic switch, in cover of starter unless otherwise indicated on the drawings. Interlocks shall be provided to provide control sequence indicated on the drawings. Interlock contact shall be provided circuit breaker of combination magnetic starters to disconnect control circuit when circuit breaker is in "off" position.

D. Operating handle of disconnect device in combination starters shall be interlocked with door to prevent opening door when starter is energized; however an inconspicuous means shall be provided to defeat this interlock. Operating handle must have provisions for not less than two padlocks.

E. Overload relay shall be solid state type and shall be selected from actual nameplate rating of motor furnished.

2.02 MANUAL MOTOR STARTERS

A. Manual motor starter shall be manually operated, trip free switching device with motor running protection overload elements in each ungrounded conductor of the motor circuit. Overload protection shall be melting alloy or bi-metallic manual reset type.

B. Manual starters installed in finished spaces shall be provided in flush mounted enclosures. Those exposed to the weather shall be provided with NEMA 4X enclosure. All other enclosures shall be NEMA one type.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Secure wall mounted magnetic starters to mounting surface with wood screws on wood, toggle bolts on hollow masonry, and lead shields on solid masonry.

B. Manual motor starters shall be provided for all fractional horsepower, single phase motors rated 1/6 HP or larger.

C. Overload element shall be selected in accordance with full load nameplate rating of motor actually served. A heater schedule shall be provided on inside cover all motor starters.

3.02 IDENTIFICATION

A. Refer to the ELECTRICAL IDENTIFICATION section of these specifications for identification requirements.

3.03 FIELD QUALITY CONTROL

A. Refer to the ELECTRICAL EQUIPMENT ACCEPTANCE TESTING section of this specifiction.

END OF SECTION

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DIVISION 26 – ELECTRICAL

263213 – ENGINE DRIVEN EMERGENCY POWER SUPPLY SYSTEM

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. The work required under this section of the specifications consists of the installation of the complete Engine Driven Emergency Power Supply System. All materials and devices which are an integral part of this system shall be provided under this section of the specifications.

B. Definition: The Emergency Power Supply System (EPSS) shall consist of one or more engine driven generator sets, each of which contains an engine directly coupled to an electric generator, together with the necessary switchgear, controls, accessories, transfer devices, and fuel supply to provide electric power for the duration of any failure of the normal power supply.

1. Automatic Transfer Switch (ATS): An automatic transfer switch is self-acting equipment for transferring one or more load conductor connections from one power source to another.

C. For this project the contractor shall provide one 450kW/563kVA diesel engine-generator set with permanent magnet excitation, a Level 2 sound-attenuated 150mph wind rated aluminum housing, 24 hr fuel capacity double wall sub-base tank, a 1200A 4-pole isolation/bypass automatic transfer switch with intermediate position.

1.03 QUALITY ASSURANCE

A. The following specifications and standards are incorporated into and become a part of this specification by reference.

1. National Fire Protection Association (NFPA):
   a. NFPA-37 Combustion Engines
   b. NFPA-70 National Electrical Code
   c. NFPA-110 Emergency and Stand-By Power Systems
2. Diesel Engine Manufacturers Association (DEMA) Standard: Standard Practices for low and medium speed stationary diesel and gas engines.
3. Electrical Generating Systems Association (EGSA) Standards:
   a. EGSA CEP2 Codes for Emergency Power by States and Major Cities

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b. EGSA GTD3 Glossary of Standard Industry Terminology and Definitions
c. EGSA ECB1 Performance Standard for Engine Cranking Batteries
d. EGSA TSS1 Performance Standard for Transfer Switches for use with Engine Generator Sets
e. EGSA BCES1 Performance Standard for Battery Chargers
f. EGSA ICAE1 Performance Standard for Electric Generator Set Instrument Control and Auxiliary Equipment

4. Institute of Electrical and Electronics Engineers (IEEE) Standards:
   a. IEEE 446 IEEE Recommended Practices for Emergency and Standby Power Systems
   b. IEEE 472 Voltage Surge Withstand Capabilities
5. National Electric Manufacturers Association (NEMA) Standards:
   a. MG-1 Motors and Generators
   b. ICS1-109 Test and Test Procedures for Automatic Transfer Switches
   c. ICS2-447 A.C. Automatic Transfer Switch
6. Underwriters Laboratories Inc. (UL) Publications:
   a. UL 1008 Automatic and Non-Automatic Transfer Switches
7. American National Standards Institute (ANSI):
   a. C37.90a Voltage Surge Withstand Capability

B. Acceptable Manufacturers: Products of the following manufacturers, which comply with these specifications, are acceptable:

1. Engine Driven Generator Sets:
   a. Cummins
   b. Caterpillar
   c. MTU
2. Transfer Switches:
   a. Cummins BTPC Series
   b. ASCO 7000 Series
3. Sub-Base Fuel Tanks:
   a. Pryco
   b. Simplex

C. Equipment Dimensions:

1. Dimensions indicated on the drawings are maximum allowable and shall not be exceeded. Where equipment of acceptable manufacturers listed exceeds the maximum dimensions, products of such manufacturers shall not be acceptable.

D. Coordination:

1. Review shop drawings submitted under this and other sections, as well as other divisions, to insure coordination between work required among different trades. Coordinate the installation sequence with other contractors to avoid conflicts and to provide the fastest overall installation schedule. Coordinate installation with architectural and structural features, equipment installed under other

sections of the specifications, and electrical equipment to insure access and to insure clearance minimums are provided.

1.04 SUBMITTALS

A. Refer to the SHOP DRAWINGS, PRODUCT DATA AND SAMPLES Section for required procedures.

B. Manufacturer's Product Data:

1. Submit material specifications and installations data for products specified under Part 2 - Products to include:
   a. Engine driven generator sets
   b. Transfer switches
   c. Sub-base fuel tanks

C. Shop Drawings: Submit shop drawings to indicate information not fully described by the product data to indicate compliance with the contract drawings. Submittals containing less than the information listed below will be rejected.

1. Shop drawings for the engine driven generator sets shall contain not less than the information listed as follows:
   a. Certification that the engine driven generator set(s) furnished will serve electrical loads indicated including motor starting loads with type(s) of starting indicated.
   b. Continuous and stand-by rating of engine driven generator set(s) including voltage and phase.
   c. Frequency and voltage regulation with maximum instantaneous voltage dip and time of recovery to stable operation.
   d. Output voltage adjustment range in percentage of rated plant voltage.
   e. Alternator type and method of connection to prime mover.
   f. Components contained in alternator instrument panel.
   g. Rating of engine at operating speed, engine cycle and number of cylinders.
   h. Type of engine lubrication system and verification of components specified.
   i. Type of engine governor.
   j. Components contained in engine instrument panel.
   k. Fuel consumption at rated load.
   l. Starting batteries including ampere hour rating.
   m. Verification that all accessories specified are to be provided. This includes tank with capacity indicated, cold weather starting aid with rating and voltage indicated, exhaust system with muffler type indicated, and outdoor housing (where applicable) with verification of space available within housing for batteries.
   n. Line and machinery constants of the generator furnished.
   o. Terminal board connection diagram where reconnectable generators are specified.

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2. Shop drawings for the transfer switch shall contain not less than the information listed as follows:
   a. List of accessories contained in the control panel.
   b. Withstand rating in RMS symmetrical amperes.

D. Quality and Service:

1. All materials and parts of the EPSS shall be new and unused. Each component shall be of current manufacture from a firm regularly engaged in the production of such equipment. Units and components offered under these specifications shall be covered by the manufacturer's parts and labor warranty for a minimum of five years from date of Owner acceptance of the project on a new machine, a copy of which shall be included in the shop drawings submittal.
2. Submittals will be accepted only on engine driven generator sets and transfer switches which can be properly maintained and serviced without requiring the Owner to stock spare parts or wait longer than twenty-four hours for service. Submittals shall include the nearest location of permanent parts outlet from which parts may be obtained and written assurance that trained service personnel will be available on twenty-four hour's notice. Units with service centers more than 50 miles from project site will not be accepted.

E. Record Drawings

1. Include in each set three sets of operating, maintenance, and parts manuals covering all components for the EPSS. Each supplier shall provide instructions to the Owner in operation and maintenance of his equipment, both in written form and with on-site personnel for a minimum of eight hours.

PART 2 - PRODUCTS

2.01 ENGINE DRIVEN EMERGENCY POWER SUPPLY (EPS)

A. Engine

1. The engine driven emergency power supply (EPS) shall be an internal combustion diesel driven prime mover. The generator set shall have the following characteristics:
   a. 450 KW Capacity
   b. 563 KVA Capacity
   c. 480Y/277V
   d. 60Hz
   e. 0.8 Power Factor
   f. 3 Phase
   g. 4-Wire
2. Maximum one-step load at 0.8 P.F. is 106.24 kW (step 1). The load to be served by this generator set consists of 132.8kVA non-inductive load plus 240 total motor horsepower. The motors shall be started as shown in the following table:

Starting Sequence				
	Initial Load	132.8KVA		
Step	Load	Quantity/HP	Code Letter	Starting
1	Pre-Areation Blowers	4/15	G	VFD
	MBR Blowers	4/15	G	VFD
2	Digester Blowers	2/15	G	VFD
	WAS Recycle Pumps	4/1.5	G	VFD
3	WAS Centrifuge Pumps	4/5	G	VFD
	Internal Recycle Pumps	8/4.7	G	VFD
4	MBR Permeate Pumps	4/5	G	VFD
	Anoxic Basin Mixer	4/1.7	G	VFD
	Odor Control (Plant)	1/6.5	G	VFD
5	Bongo Screen	9.8KVA	G	VFD
	Plant Drain PS	29.4KVA	G	VFD

Coordinate with SCADA and Ovivo to provide load starting to match steps shown.

3. The rated net horsepower of the engine at the generator synchronous speed, with all accessories, shall not be less than that required to product the KW specified in paragraph 1 above. The horsepower rating shall take into account generator efficiency and all accessory losses such as fans, battery charger, etc. The generator set shall be capable of producing the specified KW (without overload) for the duration of the power outage, under the following ambient conditions:
   a. Altitude: 50 feet above mean sea level.
   b. Air temperature at engine intake: 104 degrees F.
   c. Humidity Range: 5 - 95%.
4. Included with the shop drawing submittal shall be the manufacturer's estimate of supply fuel and oil consumption for the engine. The engine shall have an oil filter with replaceable elements, and a lube oil cooler.
5. The engine shall be equipped with a suitable governor (engine speed control) to maintain frequency within limit specified below by controlling engine and generator speed. Manufacturer shall indicate in submittal data whether mechanical, hydraulic, electrical, or hybrid governors are provided.
   a. Type: Droop - 5% maximum
   b. Stability: 1/2% maximum steady state frequency variation at any constant load from no load to full load.
   c. Regulation: 5% maximum frequency deviation between no-load steady state and full load steady state.
   d. Transient: 2 seconds maximum recovery time for maximum motor start.
6. The engine shall be electric start, provided with a solenoid energized motor with either positive engagement or clutch drive to the engine.

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7. The engine starting batteries shall be sealed lead-acid recombination type. Batteries shall be rack mounted inside the weatherproof plant housing to minimize the distance from the batteries to the starter. Provide battery straps and battery heaters.
8. A float type battery charger, compatible with the batteries selected, shall be furnished at the engine which shall maintain the starting batteries at full charge. The charging system shall permit charging from either the normal or the emergency power source.
9. It shall have an equalize rate and a float rate charging system. An ammeter and voltmeter shall indicate the charge rate and the circuit shall be protected by either fuses or circuit breakers. The charger or charging circuit shall be so designed that it will not be damaged during the engine cranking cycle, for example, by a current limiting charger or a crank disconnect relay. It shall also be capable of recharging a discharged battery in 12 hours while carrying normal loads. The charger shall be equipped with alarm relays as required for remote annunciation equipment.
10. The engine shall be liquid cooled. The type of liquid cooling system shall be unit mounted radiator - consideration shall be given for air temperature rise across the engine in addition to ambient. Minimum capacity shall be rated for 100°F. minimum engine ambient temperature plus air temperature rise across the engine.
    a. Provide an electric heater, thermostatically controlled, in the engine coolant system as a cold weather starting aid. Heater shall be for operation on 120 or 240 volt single phase A.C. and shall be permanently connected to a circuit from the electrical system. Heater shall maintain 70°F. to 90°F.
    b. Provide isolation valves or quick connect couplings for jacket water heater.
11. Air Supply/Exhaust System
    a. Cleaner: An air cleaner and silencer shall be furnished, located and mounted as recommended by the engine manufacturer.
    b. Exhaust: An exhaust system of suitable size, configuration, and material in accordance with engine manufacturer's recommendations shall connect the exhaust outlet of the engine to a silencer. The type of silencer shall meet the requirements of engine manufacturers and shall be critical. The silencer shall be located inside of the outdoor enclosure.
    c. The exhaust system including silencer shall be of such size that back pressure on the system will not exceed the back pressure permitted by the engine manufacturer's recommendation. A flexible connection shall be mounted at the engine exhaust outlet and the discharge end shall be protected against entry of precipitation. Provide vertical discharge with rain cap. Piping and silencer within reach of personnel or with 8'-0" of finished floor or grade shall be protected by screening and shall be insulated with two inches of calcium silicate insulation with aluminum jacket. All exhaust piping shall be gas tight.

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12. The engine instrument panel shall be mounted at the engine and shall contain the following:
    a. Oil pressure gauge to indicate lubricating oil pressure.
    b. Temperature gauge to indicate cooling medium temperature.
    c. Hour meter to indicate total actual running time.
    d. Battery charging meter to indicate satisfactory performance of battery charging means.
    e. Other instruments as recommended by the manufacturer for proper maintenance.
    f. Manual stop/start controls: All instruments, controls, and indicating lights shall be properly identified. All wires shall be individually identified and must agree with the wiring diagram provided. All wiring shall be harnessed or flexibly enclosed. Terminals on all terminal blocks shall be individually identified.

B. Generator

1. The generator shall be an engine-driven single or two bearings type, synchronous, brushless, conforming to applicable standards. It shall be connected to the engine flywheel by means of a flexible type coupling for single bearing generators and elastic coupling for two bearing generators.
2. The generator shall be rated for 40°C. ambient. Class of insulation shall be NEMA Class F. The voltage regulation shall be plus or minus 2% from no load to full load with plus or minus 5% speed change and a 15°C. rise in ambient. The generator voltage dip from no load to full load shall not exceed 16%.
3. The generator shall be capable of sustaining at least 250% of rated current for at least ten (10) seconds under a three phase symmetrical short by inherent design or by the addition of an optional current boost system. A resettable line sensing circuit breaker shall be furnished which protects the generator from damage due to its own high current capability. This breaker shall not trip within the ten seconds specified above to allow selective tripping of downstream fuses or circuit breakers under a fault condition.
4. Provide 120 volt condensation heater in generator windings.
5. The generator shall be the Permanent Magnet type generator.

C. Voltage Regulation

1. The generator shall be equipped with a volts-per-hertz type voltage regulator to maintain voltage within limits specified below:
    a. Stability: 2% maximum voltage variation at any constant load from no load to full load.
    b. Regulation: 4% maximum voltage deviation between no load steady state and full load steady state.
    c. Transient: 20% voltage dip or overshoot on one-step application or removal of 0.8 power factor full load.

D. Generator full main line circuit breaker.

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1. A main line circuit breaker shall be supplied to protect the generator and controls from overloads and/or short circuits in the load. It shall be rated as indicated on the drawings. Breakers shall comply with UL 489 and NEMA AB-3.

E. Start and Stop Controls

1. Automatic starting and stopping controls shall be furnished to start the engine automatically when the normal electrical power fails or falls below specific limits and to stop the engine automatically after the normal power supply resumes. The signal for starting or stopping the engine shall be sensed through an auxiliary contact in the automatic transfer switch. The controls shall be capable of operating at 50% of normal DC system supplied voltage.
2. The cranking cycle shall be initiated by manual start, loss of normal power at any transfer switch, clock exerciser, or the manually operated test switch at each ATS.
3. Crank control and the time delay relays shall provide a minimum of 4 crank attempts of at least 7 seconds each, separated by appropriate rest periods. A sensing device shall automatically disconnect the starting circuit when the engine has started. If the engine has not started at the completion of the starting program, the overcrank signal shall indicate. The engine starting controls shall be locked out and no further starting attempts shall take place until the overcranking device has been manually reset.
4. A selector switch shall be incorporated in the automatic engine start and stop controls. It shall include an "off" position that prevents manual or automatic starting of the engine; a "manual" position that permits the engine to be started manually by the pushbutton on the control cabinet and run unloaded; an "automatic" position that readies the system for automatic start or stop on demand or the automatic load transfer switches or of the programmed exerciser.
5. A remote manual stop station similar to a break-glass station shall be provided on the automatic transfer switch enclosure exterior and shall be tied into the engine controls to stop the engine when activated. Provide laminated plastic label with 1/4" minimum engraved letters to read "EMERGENCY GENERATOR SHUTDOWN". Background to be red and core to be white.

F. Instrumentation

1. Local engine control and safety panel shall be provided, containing the following:
   a. Automatic remote start capability.
   b. "Manual-Off-Auto" switch.
   c. Controls to shut down and lock out the prime mover under the following conditions: failure to start after specified cranking time, overspeed, low lubricating oil pressure, high engine temperature, or operation of remote manual stop station.
   d. Battery powered individual alarm indication to annunciate visually at the control and safety panel the occurrence of any condition itemized below;

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contacts or circuits for a common audible alarm signaling locally the occurrence of any itemized conditions listed below. Test switch shall be provided to test the operation of all lamps.

1) Indicator Function, Level 1 (At Battery Voltage):

	Control Panel Mounted Visual Indication	Shutdown of EPS	Audible
a) Overcrank	X	X	X
b) Low Water Temp. < 70°F (21°C)	X		X
c) High Engine Temp. Pre-alarm	X		X
d) High Engine Temp.	X	X	X
e) Low Lube Oil Pressure Pre-alarm	X		X
f) Low Lube Oil Pressure	X	X	X
g) Overspeed	X	X	X
h) Low Fuel Main Tank	X		X
i) EPS Supplying Load	X		
j) Control Switch Not In Auto Pos.	X		X
k) Battery Charger Malfunctioning	X		X
l) Low Voltage in Battery	X		X
m) Lamp Test	X		X
n) Contacts for Local & Remote			
o) Common Alarm	X		X
p) Audible Alarm Silencing Switch			
q) Fuel in Containment Basin	X		X
r) Remote Emergency Stop	X	X	X

2) Controls to shutdown the prime mover upon removal of initiating signal or manual emergency shutdown.
3) A.C. voltmeter with selector switch off position and positions for phase to phase and phase to neutral.
4) A.C. ammeter with selector switch with positions for each phase.
5) Frequency meter -- digital electronic type.

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6) Voltage adjusting rheostat to allow plus or minus 5% voltage adjustment.
7) Manual reset circuit breaker.
8) Water temperature gauge.
9) Manual stop/start control.
10) Elapsed time meter.
11) Panel lights.
12) Indicator lights for signals from engine instrument panel.
13) Light to indicate switch has been left in the "off" position.

2. All instruments, controls, and indicating lights shall be properly identified. All wires shall be individually identified and must agree with the wiring diagram provided. All wiring shall be harnessed or flexibly enclosed. Terminals on all terminal blocks shall be individually identified. All instrumentation must be isolated from engine generator set vibration.
3. Provide ‘alarm’ and ‘run’ contacts for connection to SCADA.

G. Enclosures and Connections:

1. All electrical enclosures, i.e, terminal cabinets, wireways, circuit breaker enclosures, etc., shall be of adequate size to provide minimum bending radius as required by the NEC for the size conductor actually terminated within or passing through the enclosure.
2. All factory provided enclosures shall have gasketing and finish appropriate for the environment in which the unit is to be mounted. All wiring, wiring harness, etc., shall be protected from the elements, such as direct sunlight, moisture, etc. or shall be UL listed for direct exposure to the applicable elements. Include written documentation of the above with the shop drawing submittal.

H. Provide flexible fuel connections at supply at return piping. Flexible hoses shall be steel reinforced type. Provide solenoid valve in series with gate valve in supply line. Solenoid valve shall be powered from generator batteries and shall be open only when generator is running.

I. Provide service lights within the generator weather enclosure.

2.02 TRANSFER SWITCH(ES)

A. Transfer switch(es) shall be rated at not less than as indicated on the drawings at rated voltage. Transfer switch(es) shall be rated and marked for total system load.

B. Transfer switch(es) serving three phase four wire loads shall be four pole. Provide timed transition type switch with intermediate position.

C. Transfer switch(es) shall be the automatic type with power contact assemblies. Transfer switches shall be U.L. listed and labeled 1008.

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D. Transfer switch(es) shall be floor mounted in a NEMA 1 painted steel enclosure. Enclosure shall have hinged door with three point latching and provisions for pad locking.

E. Operation shall be inherently double-throw whereby all contacts move simultaneously. Electrical spacing shall be equal to or exceed those listed in Table 15.1 of UL-1008. Only those main contact structures specifically designed for transfer switch service shall be acceptable. An overload or short circuit shall not cause the switch to go to a neutral position. A manual operating handle shall be provided. All main contacts shall be silver alloy type protected by arc quenchers and, for switches rated 600 amps and larger, by arching contacts. Operating transfer time shall be 1/15 second or less on switches rated below 600 amps. The transfer sequence shall be "Open Transition".

F. All switch and contacts, coils, springs and control elements shall be removable from the front of the transfer switch without removal of the switch panel from the enclosure and without disconnecting power conductors or drive linkages. Control and sensing relays shall be continuous duty industrial type with minimum contact rating of ten amps.

G. Transfer switch shall be rated to withstand in RMS symmetrical amperes not less than the available symmetrical RMS amperes when protected by the circuit protective device on the line side of the transfer switch. Withstand rating of switch shall be based on switch contacts not welding under fault conditions.

H. Transfer switches shall be U.L. listed and labeled for service entrance. Transfer switches shall be furnished with an insulated neutral, bonding jumper and a ground bar bolted to the transfer switch enclosure.

I. The control panel for each automatic transfer switch shall contain the following accessories and Features.

1. ATS Control Panel (Cummins M018 or equal)
   a. The automatic transfer switch(es) shall provide a control panel mounted into the front of the switch. This control panel shall display source condition information including:
   b. AC voltage for each phase of normal and emergency source. All three phases shall be displayed on a single screen for viewing of voltage balance and on 4-wire systems, line to neutral voltage shall be displayed for each phase.
   c. Frequency of each source.
   d. Display source status including indication whether source is/is not connected.
2. The ATS control panel shall allow the operator to make adjustments to and/or set nominal voltage and frequency of the ATS, frequency sensor operation set points, time clock functions, and load sequence functions. The operator may

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also enable/disable ATS functions, set up exercise and load test operation conditions, normal system time delays for transfer, time delay to start, stop, transfer and retransfer. These parameters may only be accessed following password input from the authorized operator.

3. The display shall include real time clock data, including date, time (HH:MM:SS) and log total operating hours for the control system.
4. The display shall include a service history for the ATS and a fault history on the ATS.
5. Adjustable 0.5 to 6 second time delay on starting of EPS to override momentary power dips and interruptions of the normal services. Time delay shall be factory set at 1 second.
6. Time delay on transfer to emergency adjustable from 0 to 60 seconds, factory set at 0 seconds.
7. Test switch on enclosure door to simulate failure of the normal power source. ATS shall transfer load to the EPS.
8. Push button to bypass time delay on re-transfer to normal.
9. Close differential voltage sensing shall be provided on all phases of the normal power supply. The pickup voltage shall be adjustable from 85% to 100% of nominal and the dropout voltage shall be adjustable from 75% to 98% of the pickup value. The transfer to emergency will be initiated upon reduction of normal source to 85% of nominal voltage and re-transfer to normal shall occur when normal source restores to 95% of nominals.
10. Independent single phase voltage and frequency sensing of the emergency source. The pickup voltage shall be adjustable from 85% to 100% of nominal. Pickup frequency shall be adjustable from 90% to 100% of nominal. Transfer to emergency upon normal source failure when emergency source voltage is 90% or more of nominal and frequency is 95% or more of nominal.
11. A time delay on re-transfer to normal source. The time delay shall be automatically bypassed if the emergency source fails and normal source is available. The time delay shall be field adjustable from 0 to 25 minutes and factory set at 15 minutes.
12. An unloaded running time delay for emergency generator cool-down, factory set at 5 minutes.
13. Provide adjustable timed intermediate position in both directions.
14. Pilot light for indicating switch in normal position (include fuses and auxiliary contact).
15. Pilot light for indicating switch in emergency position (include fuses and auxiliary contact).
16. An exerciser for exercising standby power plant on a weekly basis shall be provided in the transfer switch. Exerciser shall be set to exercise standby plant for one half hour per week under load. Time of plant exercise shall be set in field. Exerciser timer shall have reserve power back-up, either by battery or spring-wound clock, to ride through power outages to the switch.

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17. Auxiliary contact (gold plated) which closes when normal source fails. (Closed after override delay of 0.5 to 6 seconds).
18. Auxiliary contact (gold plated) which opens when normal source fails. (Opens after override delay of 0.5 to 6 seconds).
19. Auxiliary contacts on same shaft as main contacts (closed on normal.)
20. Auxiliary contacts on same shaft as main contacts (closed on emergency).

J. Bypass Isolation Switch

1. The bypass isolation switch(es) shall have the same specification requirements as the automatic transfer switch portion of this specification except as described below:
   a. The automatic transfer and bypass-isolation switch shall be provided to manually permit convenient electrical bypass and isolation of the automatic transfer switch. Bypass of the load to either the normal or emergency power source with complete isolation of the ATS shall be possible regardless of the status of the ATS. The bypass-isolation switch shall permit proper operation by one person through the movement of a maximum of two handles at a common dead front panel. The entire system shall consist of two elements: The automatic transfer switch and the bypass-isolation switch furnished completely factory interconnected and tested.
   b. The operating speed of the bypass switch contacts shall be the same as the automatic transfer switch and independent of the speed of operation of the bypass handle.
   c. The automatic transfer and bypass-isolation switch shall be the product of one manufacturer and be completely factory interconnected and tested so that only the service and load connections to the bypass-isolation switch are required for field installation. All interconnections between the transfer switch, bypass switch and isolation switch shall be by silver-plated copper bus bar. A visual position indicator shall be provided to indicate bypass-isolation switch positions, and availability of normal and emergency sources. A prominent and detailed instruction plate shall be furnished for convenient operation.
   d. The automatic transfer and bypass-isolation switch shall provide manual bypass of the load and isolation of all service and load terminals of the automatic transfer switch to permit periodic testing, maintenance, and service of the automatic transfer switch.
   e. The bypass-isolation switch shall be capable of bypassing the load to either source. Provisions shall be made to assure continuity of auxiliary circuits necessary for the proper operation of the system.
   f. The isolation handle shall provide for automatic operation, testing, or removal of the automatic transfer switch. The Test position shall permit electrical testing of the automatic transfer switch without disturbing the load. The open position shall completely isolate the transfer switch from both lines and load without actual removal of the line or load conductors, and allow its removal for inspection, adjustment and maintenance. The

transfer switch shall be arranged for drawout operation to facilitate its removal. Also, while in the Test or Open positions, the bypass switch shall function as a manual transfer switch to allow load transfer to either source of power regardless of the position or condition of the transfer switch, including the condition when the automatic transfer switch is removed, and without reconnecting the load terminals of the automatic transfer switch.

g. The isolation bypass switch cable terminations shall not require rear access. Only side and front termination permitted.

2.03 FUEL SUPPLY

A. A double wall fuel storage tank with sufficient fuel capacity to allow the EPS to operate continuously at full rated load for 24 hours (600 gallon min.) shall be located in the skids below the generator set, and shall be complete with all piping and fittings connected. No galvanized material shall be used in the tank or fueling system. The tanks shall be vented to atmosphere. A fuel level gauge shall be located as indicated on the drawings. The system shall be supplied to deliver an adequate amount of fuel to the engine from the storage tank. Pipe sizes shall be no smaller than the minimum recommended by the engine manufacturer to avoid fuel flow restriction. The engine supply and return line shall be equipped with a length of flexible fuel lines, unions, and gate valves. No copper lines are acceptable.

B. The fuel tank shall not exceed 18” high but may extend beyond the generator length and width.

C. Should the fuel tank exceed 18”, the contractor shall provide a work platform around the sides and controls end of the generator, extending a minimum of three (3) feet from the generator, but in no case shall the platform be narrower than the length of the service doors so that the generator remains fully accessible for servicing. The platform shall be provided with a handrail, three (3) feet high. The platform deck shall be equal in elevation to the top of the fuel tank and shall be supported by the concrete pad of the generator. The concrete pad shall be extended to fully support the platform and generator. The platform shall be fabricated from welded aluminum tubing, the deck shall be heavy duty aluminum grating, the platform shall be provided with aluminum steps as required to access the working deck elevation.

D. Provide a set of normally open contacts in fuel level indicating system of fuel tank. Interconnect with remote low fuel alarm specified earlier in this section.

E. Provide ‘Fuel in Containment’ contact in basin and Leak Detection System.

F. Provide 300 gallons of fuel at start of load bank testing.

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PART 3 - EXECUTION

3.01 EPS INSTALLATION

A. The plant shall be anchored to a concrete base whose overall dimensions shall exceed the outside dimensions of the plant base by 12" in each direction. Base depth shall be 12". Refer to the detail on the plans

B. Provide a laminated sign at the service entrance equipment indicating type and location of on-site emergency power sources.

C. For exterior installations, the EPS shall be provided in outdoor, weatherproof housing with removable panels for access to equipment. The starting batteries shall be rack mounted within the housing.

D. The enclosure shall be constructed of pre-painted aluminum, panels and posts shall be 0.125” thick (ASTM B209, 5052 H32). The housing shall be wind rated to 150 mph per ASCE 7-98 exposure D, category 1 importance factor. The enclosure shall be required to provide sound attenuation, level 2.

E. Provide fluorescent service lights and weather proof switch within the housing. Connect the light to the battery charger 120 volt circuit.

F. Extend 120 volt emergency power circuits for chargers and cold weather starting aids from the control panel wiring system.

G. Provide 300 gallons of fuel before testing.

3.02 TRANSFER SWITCH INSTALLATION

A. Locate transfer switch(es) to provide working clearance and full accessibility as required by the National Electrical Code.

B. Lace and group conductors installed in transfer switch with nylon tie straps. Only one conductor shall be installed under terminals. Form and train conductors in enclosure neatly parallel and at right angles to sides of box. Uninsulated conductor shall not extend beyond one-eights inch from terminal lug. Conductors shall be installed such that no stresses are transferred to terminal lugs.

C. Mounting and Support

1. Mounting
   a. Enclosure shall be secured to structure by a minimum of four (4) fastening devices. Transfer switches 400 amps and larger shall be secured by a minimum of eight (8) devices. A 1.5 inch minimum diameter round washer shall be used between head of screw or bolt and enclosure.

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b. Enclosures shall be mounted where indicated on the drawings or specified herein. Support from the structure with fastening device specified.
c. Attach enclosure directly to the wall.
d. Refer to the detail on the drawings for frame installation and construction information.
e. Do not splice conductors in enclosure. Where required, install junction box or wireway adjacent to transfer switch and splice or tap conductors in box.
f. Conductors not terminating in transfer switch shall not extend through or enter transfer switch enclosure.
g. Install push-in knock-out closure plugs in any unused knock-out openings.
h. Free standing transfer switch(es) shall be installed on a four inch high concrete pad, with horizontal base dimension exceeding base dimension of switch by three inches.
i. Cleaning and Adjustment
   1) After completion, clean the interior and exterior of dirt, paint and construction debris.
   2) Touch up paint all scratched or marred surfaces with factory furnished touch up paint of the same color as the factory applied paint.

3.03 TESTING

A. Submit verification letter to Engineer indicating successful completion of sequence of operations testing and certification that all functions are operational. Letter to request load testing approval and schedule of proposed test. Prior to load test, written approval must be provided by Engineer. Representatives of the generator and transfer switch shall be present. The local authority having jurisdiction shall be given advance notification of the time of the final test in order that he may witness the tests.

B. A failure of any test or any component during a test will require a complete retest program at no additional cost to the Owner.

C. Provide all fuel, lubricants, and other consumables for testing.

D. An on-site acceptance test shall be conducted as a final approval test for all Emergency Power Supply Systems.

1. The test shall be conducted after completion of the installation with all EPSS accessory and support equipment in place and operating.
2. Test Results. The EPSS shall perform within the limits specified in the standard NFPA-110, Level 1.

3.04 O&M MANUALS

A. At least three sets of an instruction manual(s) for all major components of the EPS shall be supplied by the Manufacturer(s) of the EPS and shall contain:

1. A detailed explanation of the operation of the system.

2. Instruction for routine maintenance.
3. Detailed instructions for repair of the EPS and other major components of the EPS.
4. Pictorial parts list and part numbers.
5. Pictorial and schematic electrical drawings of wiring systems, including operation and safety devices, control panels, instrumentation and annunciators.

END OF SECTION

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DIVISION 26 – ELECTRICAL

266500 – ELECTRICAL EQUIPMENT ACCEPTANCE TESTING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. The work required under this section of the specifications consist of the start-up testing and inspection of the electrical equipment designated within. All labor and testing equipment which is required shall be provided under this section of the specifications.

1.03 GENERAL

A. The Contractor shall perform the tests as outlined below to insure system acceptance.

B. When the tests and inspections have been completed, a label shall be attached to all devices tested. The label shall provide the name of the testing company, the date the tests were completed, and the initials of the licensed electrical contractor who performed the tests.

C. The tests shall insure that the equipment is operational and functioning within industry standards and manufacturer's tolerances. Forward all test reports to the Engineer at least two weeks prior to the project final inspection for review. Reports shall be bound as required by Division 1 of this specification.

1.04 QUALITY ASSURANCE

A. The testing and inspection shall comply with all applicable sections of the following codes and standards:

1. American National Standards Institute - ANSI
2. American Society for Testing and Materials - ASTM
3. Association of Edison Illuminating Companies - AEIC
4. Institute of Electrical and Electronics Engineers - IEEE
5. Insulated Power Cable Engineers Association - IPCEA
6. International Electrical Testing Association - NETA Acceptance Testing Specifications
7. National Electrical Code - NEC

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8. National Electrical Manufacturers Association - NEMA
9. National Fire Protection Association - NFPA
10. State and Local Codes and Ordinances

B. The inspection and testing shall comply with the project plans and specifications as well as with the manufacturer's drawings, instruction manuals, and other applicable data for the apparatus tested.

1.05 DIVISION OF RESPONSIBILITY

A. The contractor shall perform all tests.

B. The contractor shall supply a suitable and stable source of electrical power to each test site. The testing firm shall specify the specific power requirements.

C. The contractor shall notify the testing firm when equipment becomes available for acceptance tests. Work shall be coordinated to expedite project scheduling.

D. The contractor is responsible for obtaining and approving a short-circuit analysis and coordination study prepared by the switchgear manufacturer.

E. The testing firm shall notify the Engineer prior to commencement of any testing.

F. Any system, material or workmanship which is found defective on the basis of acceptance tests shall be reported to the Engineer.

G. The electrical contractor shall maintain a written record of all tests and, upon completion of project, shall assemble and certify a final test report.

1.06 SAFETY AND PRECAUTIONS

A. Safety practices shall comply with applicable state and local safety orders as well as with the Occupational Safety and Health Act of 1970 (OSHA). Compliance with the National Fire Protection Association standard NFPA 70E and the Accident Prevention Manual for Industrial Operations of the National Safety Council shall be observed.

B. Tests shall only be performed on apparatus which is de-energized. The testing company's lead test engineer for the project shall be a designated safety representative and shall supervise testing observations and safety requirements. Work shall not proceed until he has determined that it is safe to do so.

C. Power circuits shall have conductors shorted to ground by a hotline grounded device approved for the purpose. Warning signs and protective barriers shall be provided as necessary to conduct the tests safely.

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1.07 REPORTS

A. The test report shall include the following sections:

1. Scope of testing
2. Equipment tested
3. Description of test
4. Test results
5. Conclusions and recommendations
6. Appendix, including test forms

B. Each piece of equipment shall be recorded on a data sheet listing the condition of the equipment as found and as left. Included shall be recommendations for any necessary repair and/or replacement parts. The data sheets shall indicate the name of the engineer who tested the equipment and the date of the test completion.

C. Record copies of the completed test report shall be submitted no more than 30 days after completion of the testing and inspection.

1.08 TEST EQUIPMENT

A. All test equipment shall be in good mechanical and electrical condition. All field instruments shall have been calibrated within six months of the testing date, and dated calibration labels shall be visible on the testing equipment. Submit calibration certification in the final report.

PART 2 – PRODUCTS

2.01 MATERIALS

A. All materials are specified under other sections of this specification. All testing equipment required shall be provided under this section of the specifications.

PART 3 - EXECUTION

3.01 EQUIPMENT TO BE TESTED

A. The following equipment shall be tested in accordance with the scopes of work which follow. The party responsible is identified in accordance with the following key: C = Contractor; M = Manufacturer.

1. Dry Type Transformers - C
2. Low Voltage Switchgear and Switchboards - C
3. Molded Case Circuit Breakers - C
4. Motor Control Centers and Motor Controllers – M
5. Fire Alarm System – C
6. Automatic Transfer Switches - M

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7. Emergency Power Supply-Engine Driven - M
8. Lighting Control System - C
9. Grounding System - C
10. Cables, Low Voltage, 600 Volts Maximum - C
11. Ground Fault Systems - M
12. Surge Arrestors - C

3.02 DRY TYPE TRANSFORMERS

A. Visual and Mechanical Inspection

1. With case covers removed, inspect transformer core and coil assembly and enclosure interior. Cloth wipe and/or brush major insulating surfaces.
2. Check primary, secondary, and ground connections.
3. Check tap connections and tap changer.
4. Inspect all bolted connections. The electrical contractor shall torque wrench tighten or remake any questionable connections.
5. Inspect insulators, spacers, and windings.
6. Inspect for adequate electrical clearance.
7. Check base or support insulators, including vibration isolation supports.
8. Check accessory devices for condition and proper operation.
9. Verify that the transformers have been provided with adequate spacing for ventilation.

B. Electrical Tests

1. Insulation Resistance Test: Megger transformer windings high to low and ground, low to high and ground, and high and low to ground.
2. Where auxiliary cooling has been provided, verify proper operation of such equipment.
3. Include measured secondary voltage (line-to-line and line-to-ground) for each transformer in the test report. Verify that the taps on all transformers with primary voltages above 600 volts are set to deliver voltage indicated in the Contract Documents with the system in full operation. Secondary voltage readings, at each transformer, phase to phase neutral, and phase load readings shall be recorded and tap positions of transformer taps noted. This test shall be conducted with a calibrated voltmeter.
4. Each ground rod installation shall be tested after all connections to ground rods are made before grounding conductor connection is made to the transformer. Ground rod installations shall be tested by "fall of potential" measuring method using ground resistance test meter and two auxiliary electrodes driven into the earth, interconnected through the meter with the ground rod installation being tested.
5. Placement of auxiliary electrodes shall be in accordance with operating instructions of test meter, but in no case shall auxiliary current electrodes be placed within 70' of the grounding system being tested. Test data shall indicate

placement of auxiliary electrodes with respect to systems being tested, date readings were taken and lowest resistance recorded.

3.03 LOW VOLTAGE SWITCHGEAR AND SWITCHBOARDS

A. Visual and Mechanical Inspection

1. Verify that the contractor has cleaned enclosure interiors of accumulated dust, dirt, oil films, and other foreign materials.
2. Inspect all electrical and mechanical components for condition and any evidence of defects or failure.
3. Check for proper travel and alignment of any drawout or plug-in circuit breakers.
4. Check breaker connections to bus.
5. Inspect bolted connections. The electrical contractor shall torque wrench tighten or remake any questionable connections.
6. Inspect for missing or loose hardware or accessories.
7. Inspect ground bus connections.
8. Operate key and door interlock devices to assure proper operation.

B. Electrical Tests

1. Insulation Resistance Test: Megger main secondary bus and feeder circuits phase-to-phase and phase-to-ground.
2. Energize any space heater circuits to insure proper operations.

C. Check phase rotation with a Biddle phase rotation meter.

D. Instruments and Meter Tests

1. Inspect panel mounted instruments and meters. Clean and check for calibration accuracy. Make minor adjustments as necessary.

3.04 MOLDED CASE CIRCUIT BREAKERS

A. Visual and Mechanical Inspection

1. Inspect cover and case, and check for broken or loose terminals.
2. Operate breaker to check operation.

B. Electrical Tests (400 ampere frame and larger)

1. Insulation Resistance Test: Megger main poles of breaker pole-to-pole, from each pole to ground, and across the open contacts of each pole.
2. Contact Resistance Test: Ductor across main pole contacts with breaker closed and latched to check for good, low resistance contact.
3. Test overcurrent trip device and calibrate. Where primary injection testing is specified, test each pole of the breaker individually. Data shall be compared with manufacturer's published data.
   a. All trip units shall be tested by primary injection.
   b. Static overcurrent trip devices shall be tested per manufacturer's instructions.

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c. Test for minimum pick-up current.
d. Apply 300% of pick-up current and measure time necessary to trip breaker (long time delay).
e. Where short time delay characteristics are provided, test short time pick-up and delay.
f. Test instantaneous trip by passing current sufficiently high to trip breaker instantaneously.
g. Where ground fault protection is provided, test ground fault pick-up and delay.
h. Check reset characteristics of trip unit.

4. Electrically test any auxiliary devices such as shunt trips, undervoltage trips, alarm switches, and auxiliary switches.

3.05 MOTOR CONTROL CENTERS AND MOTOR CONTROLLERS

A. Visual and Mechanical Inspection

1. Verify that the contractor has cleaned structure interiors and starter cells of accumulated dust, dirt, oil films, and other foreign material.
2. Inspect bolted connections. The electrical contractor shall torque wrench tighten or remake any questionable connections.
3. Check mechanical operation of starters for freedom from binding.
4. Check motor circuit protector setting and overload relay heater size against contractor furnished list of motor nameplate full load current values.

B. Electrical Tests

1. Verify operation of each starter.
2. Test each overload relay by current injection through relay heaters. Record heater catalog numbers for each starter and submit list for maintenance. List shall contain circuit number, description of equipment and motor full load amps.
3. Contact Resistance Test. Ductor across main pole contacts of each breaker or switch with device closed and latched to check for good, low resistance contact.
4. Test overcurrent trip device of each circuit breaker trip device by current injection.

3.06 AUTOMATIC TRANSFER SWITCHES

A. Visual and Mechanical Inspection

1. Verify that contractor has cleaned enclosure interiors and all components of accumulated of dust, dirt, oil films, and other foreign material.
2. Inspect all electrical and mechanical components for condition and any evidence of defect or failure.
3. Perform inspection checks on individual components as recommended by the manufacturer.
4. Inspect connections for looseness. The electrical contractor shall torque wrench tighten or remake any questionable connections.

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5. Inspect for missing or loose hardware or accessories.
6. Check for proper mechanical operation and lubricate, as necessary.
7. Check transfer mechanism for alignment and friction-free operation. Lubricate, as necessary.
8. Check all connecting wiring for condition.

B. Electrical Tests

1. Use test switch, when available, to check the electrical operation of the transfer switch.
2. When a test switch is not available, a failure of the normal source power will be simulated by disconnecting a voltage sensing lead.
3. Test and adjust all sensing relays, and other devices specifically associated with the transfer switch.
4. Contact Resistance Test: Ductor across main pole contacts of power switching circuit breakers, switches or contactor contacts with device closed and latched to check for good, low resistance contact.

3.07 EMERGENCY POWER SUPPLY-ENGINE DRIVEN

A. Visual and Mechanical Inspection

1. Verify that contractor has cleaned enclosure interiors of accumulated dust, dirt, oil films, and other foreign material.
2. Inspect all electrical and mechanical components for condition and any evidence of defects or failure.
3. Check output circuit breaker(s) bus connection.
4. Inspect bolted connections. The electrical contractor shall torque wrench tighten or remake any questionable connections.
5. Inspect for missing or loose hardware or accessories.
6. Inspect grounding system connections.
7. Operate key and door interlock devices to assure proper operation.
8. Inspect all associated systems and circuits for proper operation, including but not limited to the fuel supply system, jacket heater, battery charger, engine mounted control panel, remote monitoring and control panel, emergency cut-off, battery lighting system, exhaust system, radiator system, and ventilator system.
9. Inspect anchoring and vibration isolation systems.

B. Electrical Tests.

1. Insulation resistance test: Megger main poles of output circuit breaker(s) pole-to-pole, from each pole to ground, and across the open contacts of each pole.
2. Contact Resistance Test: Ductor across main pole contacts of output circuit breaker(s) with breaker closed and latched to check for good, low resistance contact.
3. Follow completely the load testing procedures of the latest issue of NFPA-110 for EPS systems, including prior notification of the local inspection authority

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having jurisdiction. Include all measured data and conditions in the final report. All non-compliance items shall be corrected by the contractor and retested until full compliance with NFPA-110 is achieved.

3.08 LIFE SAFETY SYSTEM

A. Visual and Mechanical Inspection

1. Inspect each device for physical damage.
2. Check for proper labeling of conductors.
3. Inspect all test switches for proper operation.
4. Inspect all system lamps and LED's for proper operation. Replace all non-operational equipment.
5. Check all cabinet doors latches and hinges for proper operation. Adjust, lubricate, and/or repair as required.

B. Electrical Tests

1. Verify the absence of unwanted voltages between circuit conductors and ground that would constitute a hazard or prevent proper system operation.
2. Megger test all conductors (other than those intentionally grounded) for isolation from ground.
3. Test all conductors (other than those intentionally connected together) for conductor-to-conductor isolation using as insulation testing device.
4. With each circuit pair short-circuited at the far end of the circuit, circuit resistance should be measured with an ohmmeter and recorded for each circuit. Indicate ohm values on the as-built drawings.
5. The control unit shall be tested to verify it is in the normal supervisory condition as detailed in the manufacturer's manual.
6. Each initiating and indicating circuit shall be tested to confirm that the integrity of installed conductors is being properly monitored by a suitable response at the control unit. One connection each shall be opened at no less than 10% of all initiating devices and indicating appliances.
7. Each initiating device and indicating appliance of the system shall be tested for alarm operation and proper response at the control unit. All intended functions shall be tested in accordance with the manufacturer's manual including all supplementary functions. Main and standby power supplies shall be tested.
8. Check the integrity of the software program with the system in complete operation. Verify that each message reported is correct with respect to the signal received. All possible operating conditions and system troubles shall be tested. Rewrite software as required.

3.09 LIGHTING CONTROL SYSTEM

A. Visual and Mechanical Inspection

1. Inspect each device for physical damage.
2. Check for proper labeling of conductors

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3. Inspect all system lamps and LED's for proper operation. Replace all non-operational equipment.
4. Check all cabinet doors, latches, and hinges for proper operation. Adjust, lubricate, and/or repair as required.

B. Electrical Tests

1. Verify the absence of unwanted voltages between circuit conductors and ground that would constitute a hazard or prevent proper system operation.
2. Meggar test all conductors (other than those intentionally grounded) for isolation from ground.
3. Test all conductors (other than those intentionally connected together) for conductor-to-conductor isolation using as insulation testing device.
4. The control unit shall be tested to verify it is in the proper operating condition as detailed in the manufacturer's manual.
5. Each control circuit shall be tested to confirm proper operation of the circuit. Monitor the system with all building equipment energized, such as variable speed controllers, to verify the absence of control inhibiting electrical noise.

3.10 GROUNDING SYSTEM

A. Visual and Mechanical Inspection

1. Inspect wiring system outlet and junction boxes for proper grounding. Green grounding conductor shall be connected to outlet and junction boxes. Inspect a minimum of 5% of project boxes.
2. Verify connections of grounds for the secondary of separately derived grounding systems, i.e. at dry type transformers. Note type of connection, i.e. mechanical or exothermic.
3. Verify proper connection to all components of building service entrance grounding system. Note all system components which are interconnected and type of connection either mechanical or exothermic. Note depth of driven ground rods.

B. Electrical Tests (Small Systems)

1. Perform ground-impedance measurements utilizing the fall-of-potential method per ANSI/IEEE Standard 81 "IEEE Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System". Instrumentation utilized shall be specifically designed for ground impedance testing. Provide sufficient spacing so that plotted curves flatten in the 62% area of the distance between the item under test and the current electrode.

C. Electrical Tests (Large Systems)

1. When sufficient spacing of electrodes described above is impractical, perform ground-impedance measurements utilizing either the intersecting curves method or the slope method. (Ref. Nos. 40 and 41 in IEEE Std. 81.)

D. Equipment Grounds

1. Utilize two-point method of IEEE Std. 81. Measure between equipment ground being tested and known low-impedance grounding electrode or system.

E. Test Values

1. The main ground electrode system impedance-to-ground should be no greater than five (5) ohms for commercial or industrial systems and one (1) ohm of less for generating stations, transmission stations, and large industrial systems. Equipment grounds, depending on size and length of grounding conductor, should be only fractionally higher than system ground.

3.11 CABLES - LOW-VOLTAGE - 600V MAXIMUM

A. Visual and Mechanical Inspection

1. Inspect cables for physical damage and proper connection in accordance with single-line diagram.
2. Test cable mechanical connections to manufacturer's recommended values using a calibrated torque wrench.
3. Check cable color coding with applicable engineer's specifications and National Electrical Code standards.

B. Electrical Tests

1. Perform insulation-resistance test on each feeder on the riser diagram with respect to ground and adjacent conductors. Applied potential shall be 1000 volts dc for 1 minute.
2. Perform continuity test to insure proper cable connection.

C. Test Values

1. Evaluate results by comparison with cables of same length and type. Investigate any values less than 50 megohms.

3.12 GROUND-FAULT SYSTEMS (NEC 230-95)

A. Visual and Mechanical Inspection

1. Inspect for physical damage and compliance with drawings and specifications.
2. Inspect neutral main bonding connection to assure:
   a. Zero-sequence sensing system is grounded.
   b. Ground-strap sensing systems are grounded through sensing device.
   c. Ground connection is made ahead of neutral disconnect link on zero-sequence sensing systems.
   d. Grounded conductor (neutral) is solidly grounded.
3. Inspect control power transformer to ensure adequate capacity for system.
4. Manually operate monitor panels (if present) for:
   a. Trip test
   b. No trip test
   c. Nonautomatic reset
5. Record proper operation and test sequence.

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6. Set pickup and time-delay settings in accordance with the settings provided by the owner/user's electrical engineer.

B. Electrical Tests

1. Measure system neutral insulation to ensure no shunt ground paths exist. Remove neutral-ground disconnect link. Measure neutral insulation resistance and replace link.
2. Determine the relay pickup current by current injection at the sensor and operate the circuit interrupting device.
3. Test the relay timing by injecting three hundred percent (300%) of pickup current, or as specified by manufacturer.
4. Test the system operation at fifty-seven percent (57%) rated control voltage, if applicable.
5. Test zone interlock systems by simultaneous sensor current injection and monitoring zone blocking function.
6. On multiple source, tie breaker, etc., systems, devise a simulation scheme that fully proves correct operation.

C. Test Parameters

1. System neutral insulation shall be a minimum of one hundred (100) ohms, preferably one (1) megohm or greater.
2. Relay timing shall be in accordance with manufacturer's published time-current characteristic curves but in no case longer than one (1) second for fault currents equal to or greater than 3,000 amperes.
3. Relay pickup value shall be within +/- 10% of setting and in no case greater than 1200A.

3.13 SURGE ARRESTORS

A. Low-Voltage Surge Protection Devices

1. Visual and Mechanical Inspection
   a. Inspect for physical damage and compare nameplate data with drawings and specifications.
   b. Inspect for proper mounting and adequate clearances.
   c. Check tightness of connections by using calibrated torque wrench. Refer to manufacturer's instructions for proper torque levels.
   d. Check ground lead on each device for individual attachment to ground bus or ground electrode.

END OF SECTION

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SECTION 32 92 00

TURF AND GRASSES

PART 1 – GENERAL

1.01 SECTION INCLUDES

A. Seeding, planting grass, and fertilizing graded areas behind the structures, pipeline rights–of–way, roadway shoulders, slopes and other disturbed areas.

B. Seed protection.

C. Maintaining seeded areas until final acceptance.

D. Irrigation system: Contractor shall provide a permanent irrigation system to water areas showing to be planted on the landscape sheets. Submit design for approval. Use T010 or Rainbird Products.

1.02 RELATED WORK

A. Civil and Landscape plans and specifications.

1.03 DELIVERY, STORAGE, AND HANDLING

A. Deliver grass seed in original containers showing analysis of seed mixture, percentage of pure seed, year of production, net weight, date of packaging, and location of packaging. Damaged packages are not acceptable. Store in cool, dry locations away from contaminants.

B. Deliver fertilizer in waterproof bags showing weight, chemical analysis, and name of manufacturer. Damaged bags are not acceptable. Store in cool, dry locations away from contaminants.

C. Deliver sod on pallets.

D. All material shall be acceptable to Engineer prior to use.

1.04 PLANTING DATES

A. This specification provides for establishment of a permanent grass cover between the dates of March 1 and September 30. If finished earth grades are not completed in time to permit planting and establishment of permanent grass during the favorable season between dates specified above unless otherwise accepted, Contractor will be required to plant a temporary cover to protect new graded areas from erosion and to keep windborne dust to a minimum. The temporary cover shall be planted between October 1 and February 28 unless otherwise permitted.

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PART 2 – PRODUCTS

A. Contractor shall submit source and species certification documents to Engineer and Owner's Representative for review prior to installation. Supply complete information on all analysis/test methodologies and results; laboratory certifications, manufacturer's specifications, and agency approvals to the Landscape Architect/Project Engineer prior to placement of soil mixtures. In addition, provide the Landscape Architect/Project Engineer with thoroughly mixed sample of soil mixes for acceptance prior to placement. Landscape Contractor shall make modifications and improvements to soil mixes deemed necessary by the soil analysis to meet requirements specified here in before, and to ensure proper growing medium for plant material.

2.01 SEED

A. All seed shall conform to State Laws and requirements and regulations of the State Department of Agriculture.

B. The varieties of seed, as specified in Section 2.2, shall be individually packaged or bagged, and tagged to show name of seed, net weight, origin, germination, lot number, and other information required by the State Department of Agriculture.

C. Engineer reserves the right to test, reject, or accept all seed before seeding.

2.02 SEEDING SCHEDULE

A.

SEED	RATE	PLANTING DATES
Bermuda	15–lbs/acre	March 1 – September 30
Brown top millet	10–lbs/acre	
Rye	40-lbs/acre	

2.03 FERTILIZER

A. Commercial fertilizer of accepted type, conforming to State fertilizer laws at the rate as recommended by soils test.

2.04 LIME

A. Agricultural grade, ground limestone at the rate as recommended by soils test.

2.05 SPRIG

A. Healthy living stems, stolons, or rhizomes and attached roots of locally adapted grass without adhering soil, including two to three nodes and from 4 to 6 inches long. Obtain from heavy, dense certified sod. Provide sprigs which have been grown under climatic conditions similar to those in the locality of project. Coordinate harvesting and planting operations to prevent exposure of sprigs to the sun for more than 30 minutes before covering and moistening. Sprigs showing signs of wilt, mold, containing weeds, or other detrimental material or are heat damaged will be rejected.

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B. Varieties of sprig, as specified in section 2.6, shall be individually packaged or bagged, and tagged to show name of sprig, net weight, origin, and other information required by the State Department of Agriculture.

C. Sprigs shall be pure to variety specified and shall be free of other grass species, weeds or foreign matter.

D. Sprigs shall be harvested by digging (not collected above soil level), shredding sod, rototilling sod and raking, vericutting, or with a sprig harvester. Sprigs shall consist of mostly rhizomes and crowns with only a few green leaves.

2.06 SPRIGGING SCHEDULE

A.

SPRIG	RATE	PLANTING DATES
'Tifsport' Bermuda	1,000 bushels/acre (Maximum 12 week grow-in)	April 1 – August 31
Stabilize site with temporary grass seed		September 1 – March 31 (See section 2.2)

B. In areas where existing grass is to be matched, Contractor shall sprig at the rate and dates recommended by sprig distributor.

2.07 SOD

A. Sod shall be premium grade, densely rooted, good quality grass of the species and certified variety as shown on the plans, free from noxious weeds with no surface soil being visible. The sod shall be obtained from areas where the soil is reasonably fertile. Sod of specified species shall be grown from seed or sprig with not less than 95 percent germination, 85 percent pure seed, and not more than 0.5 percent weed seed. The sod shall be machine cut to a uniform soil thickness that shall contain practically all of the dense root system and not be less than 1–inch thick.

B. Before cutting, sod shall be mowed to a height of not less that 1–1/2-inches or more than 2-inches. Sod shall be cut in minimum uniform widths of 12-inches and lengths of 24 inches.

C. Sod shall be delivered to site in a fresh, moist condition with healthy green foliage. It shall be unloaded from delivery trucks on pallets or in rolls and placed in final position within 24 hours of delivery. Sod shall be protected from wind and sun and shall not be allowed to dry out before planting.

D. Sod shall be strong enough to support its own weight and retain its size and shape when suspended vertically from a firm grasp on the upper 10 percent of the section.

2.08 ACCESSORIES

A. Straw Mulch: Oat or wheat straw, reasonably free from weeds, foreign matter detrimental to plant life, and in dry condition.

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B. Excelsior Mulch: Excelsior mulch shall consist of wood fibers cut from sound, green timber. The average length of fibers shall be 4 to 6 inches. Cut shall be made in such a manner as to provide maximum strength of fiber, but at a slight angle to natural grain of the wood to cause splintering of fibers when weathering in order to provide adherence to each other and to soil.

C. Wood cellulose fiber shall be made from wood chip particles manufactured particularly for discharging uniformly on the ground surface when dispersed by a hydraulic water sprayer. It shall remain in uniform suspension in water under agitation and blend with grass seed and fertilizer to form a homogenous slurry. Mulch fibers shall intertwine physically to form a strong moisture holding mat on the ground surface and allow rainfall to percolate into underlying soil. The mulch shall be heat processed to contain no germination or growth-inhibiting factors. It shall be dyed (non-toxic) an appropriate color to facilitate metering of material.

2.09 TOPSOIL

A. Topsoil shall be fertile, friable natural loam capable of sustaining vigorous plant growth. It shall be free of any admixture of subsoil, stones over 1-inch diameter, clods of hard earth, plants, roots, sticks or other extraneous material. It shall not be excessively acid or alkaline.

2.10 PRODUCT REVIEW

A. Contractor shall provide the Engineer with a complete description of all products before ordering. The Engineer will review all products before they are ordered.

PART 3 – EXECUTION

3.01 PREPARATION

A. Areas to be seeded shall be made smooth and uniform and shall conform to the finished grade indicated on plans.

B. Remove all foreign materials, plants, roots, stones, and debris from surfaces to be seeded.

C. Grassing areas, if not loose, shall be loosened to a minimum depth of 3 inches before fertilizer, seed or sod is applied.

D. Amendments to soils shall be incorporated into loosened 3-inch top soil layer as recommended by soils tests.

E. Existing topsoil shall be stripped and stockpiled for future use in an area approved by the Owner. Contractor shall spread topsoil in all areas to have turf or grass. Contractor shall provide additional topsoil as needed at no additional cost.

F. Contractor shall provide Topsoil Analysis Tests performed by a State Agricultural Experiment Station, Soil and Water Conservation District, State University, or other qualified private testing laboratory, as acceptable to Landscape

Architect/Engineer. Soils test shall identify existing pH and nutrient levels, as well as recommended adjustments based on the type of grass to be installed.

3.02 STAND OF GRASS

A. Before acceptance of seeding, sodding, or sprigging is performed for the establishment of permanent vegetation, Contractor will be required to produce a satisfactory stand of perennial grass whose root system shall be developed sufficiently to survive dry periods and winter weather and be capable of re-establishment in spring.

B. Before acceptance of seeding is performed for the establishment of temporary vegetation, Contractor will be required to produce a stand of grass sufficient to control erosion for a given area and length of time before the next phase of construction or establishment of permanent vegetation is to commence.

3.03 SEEDING AND SPRIGGING DATES

A. Seeding and sprigging shall be performed during periods and at rates specified in their respective schedules. Seeding and sprigging work may, at discretion of Contractor, be performed throughout the year using schedule prescribed for given period. Seeding and sprigging work shall not be conducted when the ground is frozen or excessively wet. Contractor will be required to produce a satisfactory stand of grass regardless of the period of year work is performed.

3.04 APPLYING LIME AND FERTILIZER

A. Following advance preparation and placing selected material for shoulders and slopes, lime and fertilizer, if called for based on soil tests, shall be spread uniformly over the designated areas, and shall be thoroughly mixed with the soil to a depth of approximately 2 inches. Fertilizer and lime shall be applied at the rate recommended by required soils test. Unless otherwise provided, lime will not be applied for temporary seeding. In all cases where practicable, acceptable mechanical spreaders shall be used for spreading fertilizer. On steep slopes subject to slides and inaccessible to power equipment, the slopes shall be adequately scarified. Fertilizer may be applied on steep slopes by hydraulic methods as a mixture of fertilizer and seed. When fertilizer is applied with combination seed and fertilizer drills, no further incorporation will be necessary. The fertilizer and seed shall be applied together when Wood Cellulose Fiber Mulch is used. Any stones larger than 2-1/2 inches in any dimension, larger clods, roots, or other debris brought to the surface shall be removed.

3.05 SEEDING

A. Seed shall be sown within 24 hours following application of fertilizer and lime and preparation of the seedbed as specified in Section 3.4. Seed shall be uniformly sown at rate specified by the use of acceptable mechanical seed drills. Rotary hand seeders, power sprayers or other satisfactory equipment may be used on steep slopes or on other areas inaccessible to seed drills.

B. Seeds shall be covered and lightly compacted by means of cultipacker or light roller if the drill does not perform this operation. On slopes inaccessible to compaction equipment, the seed shall be covered by dragging spiked chains, by light harrowing or by other satisfactory methods.

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C. Apply water with fine spray immediately after each area has been sown.

D. Do not sow seed when ground is too dry, during windy periods or immediately following a rain.

E. If permitted by the special provisions, wood cellulose fiber mulch or excelsior fiber mulch may be used.

3.06 SEED PROTECTION (STRAW MULCH)

A. All seeded areas seeded with permanent grasses shall be uniformly mulched in a continuous blanket immediately following seeding and compacting operations, using at least 2 tons of straw per acre.

3.07 SEED PROTECTION (EXCELSIOR MULCH)

A. Seed shall be sown as specified in Section 3.05. Within 24 hours after covering of seed, excelsior mulch shall be uniformly applied at the rate of 2 tons per acre. The mulch may be applied hydraulically or by other acceptable methods. Should the mulch be placed in a dry condition, it shall be thoroughly wetted immediately after placing. Engineer may require light rolling of the mulch to form a tight mat.

3.08 SEED PROTECTION (WOOD CELLULOSE FIBER MULCH)

A. After the lime has been applied and ground prepared as specified in Section 3. 4, wood cellulose fiber mulch shall be applied at a rate of 1,500 pounds per acre in a mixture of seed and fertilizer. Hydraulic equipment shall be used for application of fertilizer, seed, and slurry of the prepared wood pulp. This equipment shall have a built-in agitation system with an operating capacity sufficient to agitate, suspend, and homogeneously mix a slurry of the specified amount of fiber, fertilizer, seed, and water. The slurry distribution lines shall be large enough to prevent stoppage. The discharge line shall be equipped with a set of hydraulic spray nozzles which will provide an even distribution of slurry on various areas to be seeded. The slurry tank shall have a minimum capacity of 1,000 gallons.

Seed, fertilizer, wood pulp mulch, and water shall all be combined into the slurry tank for distribution of all ingredients in one operation by hydraulic seeding method specified herein. Materials shall be combined in a manner recommended by the manufacturer. The slurry mixture shall be regulated so amounts and rates of application shall result in a uniform application of all materials at rates not less than amount specified. Using the color of wood pulp as a guide, equipment operator shall spray prepared seedbed with a uniform visible coat. The slurry shall be applied in a sweeping motion, in an arched stream to fall like rain, allowing wood fibers to build upon each other until an even coat is achieved.

3.09 SPRIGGING

A. Sprigs shall be placed at the date and rates as shown in section 2.06. The sprigging method shall be by broadcast sprigging, hydroplanting or row planter. Sprigging procedure shall ensure even coverage.

B. Sprigs applied by broadcast over the site with a distributor or hydroseeder shall be planted at the rates listed in section 2.06. Cover broadcast sprigs with straw

mulch immediately after broadcast and water in immediately (within 2 hours).

C. Sprigs installed by row planter creating a narrow furrow that covers 50 to 80% of the sprig with soil may use less sprig material. Rate shall be as recommended by sprig supplier to provide a solid stand of turf within the time required in Section 2.06. Water in immediately (within 1 hour).

3.10 SODDING

A. Sod shall be placed between March 1st and December 1st. However, if sod is to be placed during periods of temperatures over 90 degrees F., the Contractor shall take extra care for quick placement of sod with adequate, consistent watering necessary to ensure sod thrives as planted.

B. Sod shall be placed within 24 hours of cutting.

C. Place top elevation of sod 1/2 inch below adjoining paving or curbs.

D. All areas to be sodded shall be brought to the proper line grade or cross section as was existing prior to construction. Sod shall be placed so, upon completion, edges of sodded areas will be smooth and will conform to the proposed finished grade. Sod shall be laid smooth, edge to edge, with staggered joints. Sod shall be immediately pressed firmly into contact with the sod bed by tamping or rolling, to eliminate any air pockets. A true and even surface shall be provided, to insure knitting without displacement of the sod or deformation of the sodded areas surfaces. Do not stretch or overlap sod pieces. Following compaction, screened soil of good quality shall be used to fill all cracks. Excess soil shall be worked into the grass with rakes or other suitable equipment. On slopes steeper than 3 to 1, sod shall be fastened in place with suitable wood or metal pins to hold the sod in place. Any damage by erosion or other causes occurring after completion of grading operations shall be repaired, before commencing with the sodding operations.

E. Immediately before sodding, moisten topsoil with a fine spray to a minimum 1-inch depth. Sod shall not be laid on dry or powdery soil.

F. Sod shall be moist when laid and placed on moist ground. The sod shall be carefully placed by hand, beginning at the toe of slopes and working upwards. The length of strips shall be at right angles to flow of surface water. All joints shall be tightly butted and end joints shall be staggered at least 12 inches. Sod shall be immediately pressed firmly into the ground by tamping or rolling. Fill all joints between strips with fine screened soil. Sod on slopes shall be pegged with sod pegs to prevent movement.

G. Within two hours after sod has been placed, thoroughly water to a minimum depth of 4-inches. After sod and soil have dried, roll sodded areas to ensure good bond between sod and soil and to remove depressions and irregularities. Roll sodded areas with a roller not exceeding 150 lbs. per foot of roller width.

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PART 4 – MAINTENANCE, WARRANTY AND ACCEPTANCE

4.01 MAINTENANCE

A. Maintain grassed surfaces until final acceptance.

B. Maintenance shall consist of providing protection against traffic, watering to ensure uniform seed germination and to keep surface of soil damp, and repairing any areas damaged as a result of construction operations or erosion. Maintenance shall also include, but is not limited to, watering, weeding, cultivating, removal of dead material, lawn mowing, fertilizing, and other necessary operations.

C. The Contractor shall maintain all proposed plantings until the date of substantial completion issued by the Owner.

4.02 WARRANTY

A. All grassed areas shall be guaranteed by Contractor to be alive and healthy during the warranty period as issued by the Owner. A final walk through with the Owner shall be conducted at end of warranty period to determine if any areas require replanting. At end of warranty period, sod shall show evidence of rooting to underlying soil and shall have no competitive weed growth from either the sod or from between sod joints.

B. Any grassed area which is dead or not showing satisfactory growth shall be replaced at Contractor's expense at the end of warranty period. All replacement shall be of original quality. Replacement required because of vandalism, excessive use, or other causes beyond the control of Contractor are not part of this contract.

4.03 ACCEPTANCE

A. Before acceptance of seeding performed for the establishment of permanent vegetation, Contractor will be required to produce a satisfactory stand of perennial grass whose root system shall be developed sufficiently to survive dry periods and winter weather and be capable of reestablishment in spring.

B. A minimum coverage of 90% density over 100% of the disturbed area is required for seeded areas before project acceptance. Sprig and sod areas shall have 95% coverage over 100% of the disturbed area prior project acceptance.

END OF SECTION

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SECTION 33 05 01.03

DUCTILE IRON PIPE

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SECTION 33 05 01.03

DUCTILE IRON PIPE

PART 1 - GENERAL

1.01 DESCRIPTION

A. SCOPE:

This section specifies ductile iron pipe, ductile fittings and gaskets.

B. DEFINITION:

Where cast iron pipe is specified, the term and symbol shall mean ductile iron pipe.

1.02 REFERENCES

This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced.

Reference	Title
ANSI A21.14	Ductile-Iron Fittings 3 In. Through 24 In., for Gas
ANSI A21.52	Ductile-Iron Pipe, Centrifugally Cast, in Metal Molds or Sand Lined Molds for Gas
ANSI B16.1	Cast Iron Pipe Flanges and Flanged Fittings Class 25, 125, 250, and 800
ANSI B16.5	Pipe Flanges and Flanged Fittings
ASTM A716	Ductile-Iron Culvert Pipe
AWWA C104 (ANSI A21.4)	Cement-Mortar Lining for Ductile- Iron and Gray-Iron Pipe and Fittings for Water
ANSI/AWWA C105/A21.5	Polyethylene Encasement for Ductile-Iron Pipe Systems

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Reference	Title
AWWA C110 (ANSI A21.10)	Ductile-Iron and Gray-Iron Fittings, 3 In. Through 48 In., for Water and Other Liquids
AWWA C111 (ANSI A21.11)	Rubber-Gasket Joints for Ductile- Iron and Gray-Iron Pressure Pipe and Fittings
AWWA C115 (ANSI A21.15)	Flanged Ductile-Iron and Gray-Iron Pipe With Threaded Flanges
AWWA C150 (ANSI A21.50)	Thickness Design of Ductile-Iron Pipe
AWWA C151 (ANSI A21.51)	Ductile-Iron Pipe, Centrifugally Cast, in Metal Molds or Sand-Lined Molds, for Water or Other Liquids
AWWA C153 (ANSI A21.53)	Ductile-Iron Compact Fittings, 3 In. Through 12 In. for Water and Other Liquids
AWWA C600	Installation of Ductile-Iron Water Mains and Their Appurtenances
AWWA C606	Grooved and Shouldered Type Joints

PART 2 - PRODUCTS

2.01 GENERAL

Pipe design, materials and manufacture shall comply with the following documents:

Item	Document
Thickness design	AWWA C150
Manufacturing requirements	
Water or other liquid	AWWA C151
Gas	ANSI A21.52
Gravity service pipe	ASTM A716
Joints	
Rubber gasket	AWWA C111
Threaded flange	AWWA C115
Fittings	
Water or other liquid	AWWA C110/AWWA C153
Gas	ANSI A21.14
Cement mortar lining	AWWA C104

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2.02 PIPE

Ductile iron pipe shall be in accordance with ANSI A21.50/AWWA C150 and conform to the requirements of A21.51/AWWA C151, latest standards. Push-on, and restrained joint pipe shall have a minimum rated working pressure of 150 psi. All buried pipe shall have the minimum pressure class listed below:

Pipe Sizes (inches)	Pressure Class (psi)
4-12	350
14-20	250
24	200
30-64	150

2.03 GASKETS

Unless otherwise specified, gaskets shall be standard styrene butadiene copolymer (SBR) with a max service temperature in water/sewer and air of 150 degrees F. and shall be suitable for freshwater, saltwater and sanitary sewer application. Mechanical joint rubber gasket configuration and materials shall comply with AWWA C111 and shall be in accordance with the applicable joint type and pressure rating of the piping system. Gaskets shall, in addition, comply with AWWA C111 for push-on and mechanical joints and with AWWA C606 for grooved end joints. If organic solvents or petroleum products are encountered during the course of the work, alternate gasket materials or joint treatment may be required by the Engineer.

2.04 FITTINGS

Unless otherwise specified, fittings shall conform to AWWA C110. Ends shall be flanged, restrained mechanical joint, restrained push-on, or grooved to suit the conditions specified. The AWWA C153 compact ductile iron fittings in sizes 3 through 12 inches are an acceptable substitute for standard fittings unless otherwise specified. Long-radius elbows shall be provided where specified. Grooved end fittings shall comply with paragraph 40 27 05-1.02 B.

2.05 JOINTS

A. UNRESTRAINED JOINTS:

1. PUSH-ON JOINTS: Unrestrained joints, where specified, shall be the rubber ring compression, push-on type joint suitable for buried service. Unrestrained joints shall be the Fastite Joint as manufactured by American Cast Iron Pipe Company, the Tyton Joint as manufactured by U.S. Pipe, or equal. This joint is not permitted on fittings or specials, unless otherwise specified. Unless otherwise specified, joints shall have an allowable deflection up to 5 degrees at specified pressures. Joint assembly and field cut joints shall be made in strict conformance with AWWA C600 and manufacturer's recommendations.

2. MECHANICAL JOINTS: Where specified, mechanical joints for above or below ground service shall meet the requirements of ANSI/AWWA

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A21.10/C110 and ANSI/AWWA A21.11/C111. Gaskets and bolts and nuts shall comply with paragraphs 33 05 01.03-2.03 and 2.05 D, respectively.

B. RESTRAINED JOINTS:

1. GENERAL: Unless otherwise specified, restrained joints are required for all exposed and buried piping. Unless otherwise specified, restrained joints shall be flanged or grooved end for exposed service and restrained push-on for buried service.

2. PUSH-ON JOINTS: Restrained push-on joints shall be as specified in paragraph 33 05 01.03-2.05 A.1., modified for restraint. Joints shall be the Flex-Ring or Lok-Ring Joint as manufactured by American Cast Iron Pipe Company, TR Flex Joint as manufactured by US Pipe, or equal. Restrained joints shall be capable of being deflected after full assembly. Joint assembly shall be in strict conformance with AWWA C600 and manufacturer's recommendations. No field cuts of restrained pipe are permitted without prior approval of the Construction Manager.

3. FLANGE ASSEMBLIES: Unless otherwise specified, flanges shall be ductile iron and shall be threaded-on flanges conforming to ANSI/AWWA A21.15/C115 or cast-on flanges conforming to ANSI/AWWA A21.10/C110. Flanges shall be adequate for 250 psi working pressure. Bolt circle and bolt holes shall match those of ANSI B16.1, Class 125 flanges and ANSI B16.5, Class 150 flanges. Where specified, flanges shall be threaded-on or cast-on flanges conforming to ANSI B16.1, Class 250.

   Unless otherwise specified, bolts and nuts for flange assemblies shall conform with paragraph 40 27 05.04-2.01 C. Gaskets shall be as specified in paragraph 40 27 05.04-2.01 B.

4. MECHANICAL JOINTS: Where specified, restrained mechanical joints shall be the positive restraint type. Mechanical joints with retainer glands are not acceptable.

   Locked mechanical hydrant tees, bends and adapters are an acceptable substitute for anchoring fire hydrants and valves to the pipe main.

5. Restrained Joints: Shall be EBBA Megalug or approved equal.

C. BALL AND SOCKET FLEXIBLE JOINT PIPE:

Ball and socket flexible joint pipe shall be the boltless type and shall allow a maximum joint deflection of 15 degrees. Each joint shall be provided with a retainer lock to prevent rotation after assembly. Joints shall be the Flex-Lok Joint as manufactured by American Cast Iron Pipe Company, USIflex as manufactured by U.S. Pipe, or equal.

D. BOLTS AND NUTS:

Stainless steel (SS316) bolts and nuts for use with ductile iron joints shall used. Bolts and nuts shall be lubricated with an Owner-approved anti-seize compound.

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2.06 PIPE COATING

Unless otherwise specified, pipe and fittings shall be coated with asphaltic material (min. 1mil) as specified in AWWA C151.

2.07 PIPE LINING

A. WATER AND REUSE WATER LININGS

Cement mortar lining is advisable for lines handling pH levels ranging from 6-10. Other pH levels shall have suitable lining. Ductile iron pipe, specials, and fittings shall be lined with cement mortar lining in accordance with AWWA C104.

B. SEWAGE SERVICE LININGS

Ductile iron pipe and fittings shall receive an interior lining of 40-mil (min.) nominal Protecto 401 epoxy, or equal.

C. SCUM & GRIT LINING

Glass lined.

2.08 PRODUCT DATA

The following information shall be provide:

1. Shop drawings.

2. Alignment drawings.

3. Certifications specified in the following documents:

ANSI A21.14, paragraph 14-4.2
ANSI A21.52, paragraph 52-4.2
ASTM A716, paragraph 4.2
AWWA C110, paragraph 10-5.3
AWWA C111, paragraph 11-7.1
AWWA C115, paragraph 15-4.2
AWWA C151, paragraph 51-5.2
AWWA C153, paragraph 53-6.3
AWWA C606, paragraph 4.1.1.1

2.09 QUALITY ASSURANCE

Contractor shall submit evidence that the ductile iron pipe and fitting manufacturer has a minimum of ten years' experience in material production of diameters noted on the plans and specifications. Ductile iron pipe is preferred to be domestically manufactured in the United States. All pipe material suppliers shall be ISO registered or provide the services of an independent inspection agency. Prior to the start of manufacturing, any manufacturer not meeting the ISO registration requirements shall submit to the Owner and Owner's Engineer the names of an independent inspection agency for approval.

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2.10 PRODUCT DELIVERY, STORAGE & HANDLING

Material shall be unloaded in a manner that will avoid damage and shall be stored where it will be protected and will not be hazardous to traffic. It shall be handled according to manufacturer's recommendations. A fork inserted inside the pipe is not allowed. The Contractor shall repair or replace any damage caused by the storage or handling. Material shall be examined before installation and neither damaged nor deteriorated material shall be used in the work. Owner and Engineer have the right to reject defective or damaged material.

Delivery, storage, and handling of ductile-iron pipe and fittings shall follow the recommendations of AWWA C600 and as specified herein:

a. Handling of pipe shall be performed with lifts, cranes, or other suitable equipment and devices. Slings, hooks, or pipe tongs shall be padded and used in such a manner as to prevent damage to the pipe, linings, and coatings. The pipes shall not be dropped or dragged.
b. During transport, the pipe shall be supported and secured against movement using padded devices in such a manner to prevent damage.
c. Stored pipe shall be protected from damage and kept free from dirt and foreign materials by closing the ends of the pipe. Other pipeline materials shall be protected by appropriate packaging or wrapping. Gaskets shall be stored in a cool location out of direct sunlight. Bolts, nuts, and washers shall be handled and stored in a dry location in a manner that will ensure proper use with respect to types and sizes.
d. Pipe laid out for installation shall be placed on earth berms or timber cradles adjacent to the trench in the numerical order of installation.
e. Maintain plastic end caps on all pipe and fittings in good condition until the pipe is ready to be installed in the trench. Periodically open the plastic end caps and spray clean potable water inside the pipe for moisture control.
f. Under no circumstances shall ropes or other handling devices be attached through the interior of fittings

2.11 RECYCLED/EFFLUENT WATER IDENTIFICATION

Ductile-iron pipe and fittings for recycled or effluent water shall be identified with purple-colored coating, sleeves, identification labels or signs.

PART 3 - EXECUTION

3.01 INSTALLATION

A. GENERAL:

Piping runs specified on the drawings shall be followed as closely as possible. Proposed deviations shall be submitted.

Pipe shall be installed in accordance with AWWA C600.

Connections to existing structures and manholes shall be made so that the finished work will conform as nearly as practicable to the requirements specified for the new manholes, including necessary concrete work, cutting and shaping. Concrete mortar shaping within any structure and manhole shall be as specified.

B. INSULATING SECTIONS:

Where a metallic nonferrous pipe or appurtenance is connected to ferrous pipe or appurtenance, an insulating section shall be provided as specified in paragraph 40 27 05.04-3.05.

C. ANCHORAGE:

Anchorage shall be provided as specified. Calculations and drawings for proposed alternative anchorage shall be submitted.

3.02 ACCEPTANCE TESTING

Hydrostatic pressure tests shall be conducted in accordance with Section 4 of AWWA C600 except that test pressures and allowable leakage shall be as listed in Section 40 27 05.

The Contractor shall conduct the tests in the presence of the Engineer or Owner.

END OF SECTION

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SECTION 33 05 01.09

POLYVINYL CHLORIDE (PVC) PRESSURE PIPE AND FITTINGS

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SECTION 33 05 01.09

POLYVINYL CHLORIDE (PVC) PRESSURE PIPE AND FITTINGS

PART 1 – GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. American Water Works Association (A WW A):

   a. C110, Ductile-Iron and Gray-Iron Fittings for Water.
   b. C116, Protective Fusion Bonded Epoxy Coating for the Interior and Exterior Surfaces of Ductile Iron and Grey iron Fittings for Water Supply Service.
   c. C153, Ductile-Iron Compact Fittings, for Water Service.
   d. C605, Underground Installation of Polyvinyl Chloride (PVC) Pressure Pipe and Fittings for Water.
   e. C900, Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 4 Inches through 12 Inches (100 mm through 300 mm), for Water Distribution.
   f. C905, Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 14 Inches through 48 Inches (350 mm through 1,200 mm) for Water Transmission and Distribution.
   g. C907, Injection-Molded Polyvinyl Chloride (PVC) Pressure Fittings, 4 Inches through 12 Inches (100 mm through 300 mm), for Water Distribution.

2. ASTM International (ASTM):

   a. D1784, Standard Specification for Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds.
   b. D2241, Standard Specification for Rigid Poly (Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series).
   c. D2321, Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications.
   d. D2672, Standard Specification for Joints for IPS PVC Pipe Using Solvent Cement.
   e. D2855, Standard Practice for Making Solvent-Cemented Joints with Poly (Vinyl Chloride) (PVC) Pipe and Fittings.
   f. D3139, Standard Specification for Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals.

3. NSF International (NSF).

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1.02 SUBMITTALS

A. Action Submittals: Drawings showing pipe diameter, pipe class, and fitting details.

B. Informational Submittals:
1. Manufacturer's Certificate of Compliance, in accordance with Section 01 0001, General Requirements.
2. Testing Plan: Submit at least 15 days prior to testing and at minimum, include the following:

   a. Testing dates.
   b. Piping systems and section(s) to be tested.
   c. Method of isolation.
   d. Method of conveying water from source to system being tested.
   e. Calculation of maximum allowable leakage for piping section(s) to be tested.

3. Certification of Calibration: Approved testing laboratory certificate if pressure gauge for hydrostatic test has been previously used. If pressure gauge is new, no certificate is required.
4. Test report documentation.

1.03 DELIVERY, STORAGE, AND HANDLING

A. Solvent Cement: Store in accordance with ASTM D2855.

PART 2 – PRODUCTS

2.01 MATERIALS

A. Pipe:

1. PVC, conforming to requirements of AWWA C900 for diameters 12 inches and smaller or AWWA C905 for diameters larger than 12 inches.
2. DR shall be 18 for C900 pipe and 25 for C905 pipe.
3. Pipe to be used for potable water conveyance shall be manufactured from National Sanitation Foundation (NSF) approved compounds.

B. Joints:

1. Rubber gasketed.
2. Conform to AWWA C900 or AWWA C905.

C. Fittings: Conforming to AWWA C153 or AWWA C110. Fusion bonded epoxy coating (interior and exterior) ductile iron or cement-lined ductile iron as specified on the Pipe Schedule included as a supplement to Section 40 27 00, Process Piping-General.

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D. Service Saddles:

1. Double strap type with minimum strap width of 2 inches.
2. Straps shall be Type 304 stainless steel. Saddles shall be Romac 202NS nylon coated saddles or approved equal.
3. Minimum Pressure Rating: 150 psi.

E. Restrained Joints:

Restrained joints for pipe, valves and fittings shall be mechanical joints with ductile iron retainer glands equivalent to “Megalug” or push-on type joints equivalent to "Lok-Ring," "TR Flex," or "Super Lock" and shall have a minimum rated working pressure of 250 psi for ductile iron pipe and 100 psi with a minimum safety factor of 2:1 for PVC pipe. The joints shall be in accordance with the applicable portions of AWWA C-111. The manufacturer of the joints shall furnish certification, witnessed by an independent laboratory, that the joints furnished have been tested without signs of leakage or failure. Restrained joints shall be capable of being deflected after assembly.

PART 3 – EXECUTION

3.01 INSTALLATION

A. In accordance with A WW A C605.

B. Solvent cement used for joints as recommended by pipe manufacturer.

C. Joints:

1. Rubber Gasketed: In accordance with manufacturer's written instructions.
2. Solvent Cemented: In accordance with ASTM D2855.
3. Restrained Joint Systems: In accordance with manufacturer's written instructions.

D. Pipe Bending for Horizontal or Vertical Curves:

1. Radius of curves shall not exceed 75 percent of manufacturer’s recommended values.
2. Use blocks or braces at pipe joints to ensure axial deflection in gasketed or mechanical joints does not exceed allowable deflection.

E. Maximum Joint Deflection: 75 percent of manufacturer’s recommended values.

3.02 INSPECTION AND HYDROSTATIC TESTING

A. General: In accordance with Section 40 80 01, Process Piping Leakage Testing.

END OF SECTION

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SECTION 33 05 01.12

GRAVITY SEWER PIPE AND FITTINGS

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SECTION 33 05 01.12

GRAVITY SEWER PIPE AND FITTINGS

PART 1 – GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. American Water Works Association (AWWA):

   a. C105, Polyethylene Encasement for Ductile Iron Pipe Systems.
   b. C110, Ductile-Iron and Gray-Iron Fittings, 3 in. Through 48 in. (75 mm through 1200 mm), for Water.
   c. C111, Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
   d. C205, Cement-Mortar Protective Lining and Coating for Steel Water Pipe -4 in. (100 mm) and Larger -Shop Applied.
   e. C208, Dimensions for Fabricated Steel Water Pipe Fittings.
   f. C302, Reinforced Concrete Pressure Pipe, Noncylinder Type.
   g. C900, Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 4 in. Through 12 in. (100 mm through 300 mm), for Water Distribution.

2. ASTM International (ASTM):

   a. A615/A615M, Standard Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement.
   b. A746, Standard Specification for Ductile Iron Gravity Sewer Pipe.
   c. C76, Standard Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe.
   d. C150, Standard Specification for Portland Cement.
   e. C151, Ductile-Iron Pipe, Centrifugally Cast, for Water.
   f. C361, Standard Specification for Reinforced Concrete Low-Head Pressure Pipe.
   g. C425, Standard Specification for Compression Joints for Vitrified Clay Pipe and Fittings.
   h. C443, Standard Specification for Joints for Circular Concrete Sewer and Culvert Pipe, Using Rubber Gaskets.
   i. C596, Test Method for Drying Shrinkage of Mortar Containing Hydraulic Cement.
   j. C700, Standard Specification for Vitrified Clay Pipe, Extra Strength, Standard Strength, and Perforated.
   k. D16, Standard Terminology for Paint, Related Coatings, Materials, and Applications.
   l. D1248, Standard Specification for Polyethylene Plastics Extrusion Materials for Wire and Cable.
   m. D1784, Standard Specification for Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds.

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n. D2241, Standard Specification for Poly (Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series).
o. D2412, Standard Test Method for Determination of External Loading Characteristics of Plastic Pipe by Parallel-Plate Loading.
p. D3034, Standard Specification for Type PSM Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings.
q. D3212, Standard Specification for Joints For Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals.
r. E329, Standard Specification for Agencies Engaged in the Testing and/or Inspection of Materials Used in Construction.
s. F477, Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe.
t. F679, Standard Specification for Poly (Vinyl Chloride) (PVC) Large-Diameter Plastic Gravity Sewer Pipe and Fittings.

1.02 DEFINITIONS

A. SDR: Standard Dimension Ratio.

1.03 SUBMITTALS

A. Action Submittals: Information on gasket polymer properties.

B. Informational Submittals:

1. Certificates:

a. Manufacturer's Certificate of Compliance, in accordance with Section 01 0001, General Requirements, that products furnished meet requirements of this section.
b. Certified statement from manufacturer of gaskets, setting forth that basic polymer used in gaskets and test results of physical properties of compound are in accordance with ASTM F477 for PVC pipe.

2. Manufacturer's Written In-Plant Quality Control Program: Quality control procedures and materials testing to be used throughout manufacturing process. Submit prior to manufacture of any pipe for this Project.
3. Test or historical performance data to verify that joint design meets requirements of these specifications.
4. Provide pipe test results with delivery of pipe. Do not deliver pipe not meeting test requirements to Project Site.
5. Manufacturer's written recommendations for pipe handling and installation.
6. PVC pipe deflection test results.

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PART 2 – PRODUCTS

2.01 POLYVINYL CHLORIDE PIPE (PVC)

A. 15-Inch Diameter and Smaller:

1. In accordance with ASTM D3034.
2. Joints: Integral bell and spigot, in accordance with ASTM D3212.
3. Minimum SDR: 26.
4. Cell Classification: 12454-B or 12454-C, as defined by ASTM D1784.
5. Fittings: SDR 35 minimum wall thickness.
6. Gaskets: Factory fabricated rubber compression type with solid cross section in accordance with ASTM F477. Lubricant for joining pipe as approved by pipe manufacturer.

2.02 FLEXIBLE COMPRESSION COLLAR

A. Mechanical joint coupling with No. 305 stainless steel bands.

B. Manufacturers:

1. Calder, Inc., Bellflower, CA.
2. Femco Inc., Davison, MI.

PART 3 – EXECUTION

3.01 EXAMINATION

A. Notify Engineer immediately of manufacturing imperfections or damage caused by improper handling.

B. Verify size, pipe condition, and pipe class prior to installation of pipe.

3.02 PREPARATION

A. Pipe Distribution: Do not distribute more than 1 week's supply of materials in advance of laying, unless otherwise approved by Engineer.

B. Inspect pipe and fittings prior to lowering into trench to ensure no cracked, broken, or otherwise defective materials are being used.

C. Remove foreign matter and dirt from inside of pipe and fittings and keep clean during and after laying. Wash ends of section clean with wet brush prior to joining sections of pipe.

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3.03 INSTALLATION

A. General:

1. Install pipe sections in accordance with manufacturer's recommendations.
2. Provide and use proper implements, tools, and facilities for safe and proper prosecution of Work.
3. Lower pipe, fittings, and appurtenances into trench, piece by piece, by means of crane, slings, or other suitable tools and equipment, in such a manner as to prevent damage to pipe materials, protective coatings and linings. Do not drop or dump pipe into trenches.

B. Line and Grade:

1. Establish line and grade for pipe by use of lasers.
2. Measure for grade at pipe invert, not at top of pipe.
3. Do not deviate from line or grade, as shown on Drawings, more than *1/2* inch, provided that such variation does not result in a level or reverse sloping invert.

C. Laying and Jointing:

1. Use gasket lubricant as recommended by gasket manufacturer.
2. Lay pipe upgrade with bell ends pointing in direction of laying.
3. When field cutting or machining pipe is necessary, use only tools and methods recommended by pipe manufacturer and approved by Engineer.
4. After section of pipe has been placed in its approximate position for jointing, clean end of pipe to be joined, inside of joint, and rubber ring immediately before joining pipe.
5. Assemble joint in accordance with recommendations of manufacturer.
6. Apply sufficient pressure in making joint to assure that joint is "home" as defined in standard installation instructions provided by pipe manufacturer. Inside joint space shall not exceed 50 percent of pipe manufacturer's recommended maximum allowance.
7. Place pipe to specified line and grade to form smooth flow line.
8. Ensure that bottom of pipe is in contact with bottom of trench for full length of each section.
9. Check for alignment and grade after joint has been made.
10. Place sufficient pipe bedding material to secure pipe from movement before next joint is installed.
11. When pipe is laid within movable trench shield, take precautions to prevent pipe joints from pulling apart when moving shield ahead.

    a. When laying operations are not in progress, and at close of day's work close and block open end of last laid section of pipe to prevent entry of foreign material or creep of gasketed joints.
    b. Take precautions to prevent "uplift" or floating of line prior to completion of backfill operation.

c. Connections between one pipe material and another shall be by means of flexible compression collar, installed in accordance with the manufacture's recommendations, or concrete closure collar.

D. Connection to Structure or Manhole:

1. Locate standard pipe joint within 1.5 feet of outside face of structure for pipe 18 inches and smaller and within one pipe diameter for pipe 21 inches and larger.
2. Plug or close off pipe stubbed with watertight plug.
3. Connect PVC pipe to manhole with pipe to manhole connector in accordance with manufacturer's recommendations.

3.04 CLEANING

A. Clean each section of completed sewer pipeline prior to testing.

B. Place screen or dam in downstream manhole of section being cleaned to catch debris.

C. Remove material from each manhole section before cleaning the next section downstream.

D. Method: High velocity hydro-cleaning equipment.

E. Cleaning water may not be discharged into existing sewer system after screening and removal of debris.

3.05 GASKET FIELD SPLICE TESTS

A. Perform field splice test on 20 percent of each lot of delivered gaskets, in accordance with ASTM C361 in presence of Engineer.

B. Furnish feeler gauges of proper size, type, and shape to verify proper placement of gasket.

C. Test section of gasket shall be at point where ends of gasket are joined together.

D. If gasket joints separate during test, entire lot will be rejected and shall immediately be removed from Site.

3.06 HYDROSTATIC AND PNEUMATIC TESTS

A. General: In accordance with 408001, Process Piping Leakage Testing.

END OF SECTION

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WASTEWATER PUMP STATIONS

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SECTION 33 32 20

WASTEWATER PUMP STATIONS

PART 1 – GENERAL

1.01 SECTION INCLUDES

A. Sewer Pipes.

B. Pumping Station Upgrade.

1.02 RELATED SECTIONS

A. Section 33 32 21 – Flow Diversion (Bypass Pumping).

B. Section 01 75 15 – Pump Station – Start up.

1.03 OPTIONS

A. The specifications describe several materials. The Owner will decide which ones to be used. Where manufacturers and models of equipment are named in the specifications, it is intended these are to describe quality and function required. Contractor may use equipment or materials of other manufacturers provided they are reviewed and accepted by the Engineer, Owner, and Regulatory Agency and Operator as equivalent to those specified.

1.04 REFERENCES (Latest Revision)

A. ASTM D 3034 – Type PSM Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings.

B. ANSI/AWWA C 150/A 21.50 – Thickness Design of Ductile Iron Pipe.

C. ANSI/AWWA C 151/A 21.51 – Ductile Iron Pipe, Centrifugally Cast, for Water, or Other Liquids.

D. ASTM A 746 – Ductile Iron Gravity Sewer Pipe.

E. ASTM D 3212 – Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals.

F. ASTM F 477 – Elastomeric Seals (Gaskets) for Joining Plastic Pipe.

G. ASTM D 2241 – Poly (Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series).

H. ASTM D 3139 – Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals.

I. ASTM C 443 – Joints for Concrete Pipe and Manholes, Using Rubber Gaskets.

J. ACI 318 – Building Code Requirements for Structural Concrete.

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K. ASTM C 39/C 39M – Compressive Strength of Cylindrical Concrete Specimens.

L. ASTM C 890 – Minimum Structural Design Loading for Monolithic or Sectional Precast Concrete Water and Wastewater Structures.

M. ASTM C 891 – Installation of Underground Precast Concrete Utility Structures.

N. ASTM C 913 – Precast Concrete Water and Wastewater Structures.

O. ASTM A 615/A 615 M – Deformed and Plain Carbon – Steel Bars for Concrete Reinforcement.

P. ASTM D-6938 – In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth).

Q. ASTM D 2794 – Resistance of Organic Coatings to the Effects of Rapid Deformation (Impact).

R. ASTM E 96 – Water Vapor Transmission of Materials.

S. ASTM G 154 – Operating Fluorescent Light Apparatus for UV Exposure of Nonmetallic Materials.

T. ANSI/AWWA C 111/A 21.11 – Rubber-Gasket Joints for Ductile Iron Pressure Pipe and Fittings.

U. ASTM A 377 – Index of Specifications for Ductile Iron Pressure Pipe.

V. ANSI/AWWA C 600 – Installation of Ductile Iron Water Mains and Their Appurtenances.

W. ANSI/AWWA C115/A21.15 – Flanged Ductile Iron Pipe with Ductile Iron or Gray Iron Threaded Flanges.

X. ANSI/AWWA C900 – Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 4 Inches through 12 inches, for Water Transmission and Distribution.

Y. ANSI/AWWA C905 – Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 14 Inches through 48 inches, for Water Transmission and Distribution.

1.05 QUALITY ASSURANCE

A. Contractor will furnish the Engineer and Owner a description of <u>all</u> material before ordering. Engineer will review the Contractor's submittals and provide in writing an acceptance or rejection of material.

B. Where ductile iron pipe is indicated on the plans, or required by Engineer, it shall be used.

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C. Material and equipment shall be the standard products of a manufacturer who has manufactured them for a minimum of two years and provides published data on their quality and performance.

D. A subcontractor for any part of the work must have experience on similar work, and if required, furnish Engineer with a list of projects and Owners or Engineers who are familiar with its competence.

E. If Contractor wishes to furnish devices, equipment, structures, and systems not designed by Engineer, these items shall be designed by either a Professional Engineer registered in the project state or by someone Engineer accepts as qualified. If required, complete design calculations and assumptions shall be furnished to the Engineer or Owner before acceptance.

F. Testing shall be by a testing laboratory which operates in accordance to ASTM D 3740 or E 329 and shall be acceptable to Engineer prior to engagement. Mill certificates of tests on materials made by manufacturers will be accepted provided the manufacturer maintains an adequate testing laboratory, makes regularly scheduled tests, spot checked by an outside laboratory, and furnishes satisfactory certificates with name of entity making test.

G. Pump performance, and hydrostatic tests on force mains shall be made by Contractor with equipment qualified by Engineer and in the presence of Engineer. Engineer or Project Representative reserves the right to accept or reject testing equipment.

H. Perform work in accordance with the State of South Carolina, South Carolina Department of Health and Environmental Control minimum standards.

I. Install pumps and their associated mechanical, electrical and control accessories according to manufactures instructions.

J. Infiltration, line, and grade of sewer, pump performance, and hydrostatic tests on force mains shall be made by Contractor with equipment qualified by Engineer and in the presence of Engineer. Engineer or Project Representative reserves the right to accept or reject testing equipment.

1.06 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. Material shall be unloaded in a manner avoiding damage and shall be stored where it will be protected and will not be hazardous to traffic. If stored on private property, Contractor shall obtain permission from property owner and shall repair any damage caused by the storage. Material shall be examined before installation. Neither damaged nor deteriorated material shall be used in the work.

B. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.

C. Protect piping system from entry of foreign materials and water by temporary covers, completing sections of work, and isolating parts of complete system.

D. Accept system components on site in manufacturer's original containers or configuration. Inspect for damage.

E. Store sensitive materials for field assembly in dry area in original shipping containers.

F. Repair damage to wet well and other infrastructure according to manufacturer's instructions.

1.07 JOB CONDITIONS

A. Installation of the improvements must be coordinated with ongoing operations.

B. Contractor shall replace or repair any damaged pipe or structure at no additional expense to the Owner.

C. Installation of the sanitary sewerage system must be coordinated with other work on site. Generally, sanitary sewer pipes will be installed first and shall be backfilled and protected so subsequent excavating and backfilling of other utilities does not disturb them. Contractor shall replace or repair any damaged pipe or structure at no additional expense to the Owner.

1.08 ALTERNATIVES

A. The intention of these specifications is to produce the best system for the Owner. If the Contractor suggests alternate material, equipment or procedures will improve results at no additional cost, Engineer and Owner will examine suggestion, and if accepted, it may be used. The basis upon which acceptance of an alternate will be given is its value to the Owner, and not for Contractor's convenience.

1.09 GUARANTEE

A. Contractor shall guarantee quality of materials, equipment, and workmanship for 12 months after acceptance of the completed Project. Defects discovered during this period shall be repaired by Contractor at no cost to the Owner.

1.10 EXISTING UTILITIES

A. All known utility facilities are shown schematically on the construction drawings, and are not necessarily accurate in location as to plan or elevation. Utilities such as service lines or unknown facilities not shown will not relieve the Contractor of responsibility under this requirement. "Existing Utilities Facilities" means any utility existing on the project in its original, relocated, or newly installed position. Contractor will be held responsible for cost of repairs to damaged underground facilities, even when such facilities are not shown on the drawings.

B. The Contractor shall call for underground utility locations before starting work. Underground utilities location service can be contacted at 1-888-721-7877 (SC) or 811.

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1.11 TESTING

A. Laboratory tests for moisture density relationship for fill materials shall be in accordance with ASTM D 1557, (Modified Proctor).

B. In place density tests in accordance with ASTM D 2922.

C. Testing laboratory shall operate in accordance with ASTM D 3740 and E 329 and be acceptable to the Engineer.

D. Testing laboratory and Project Engineer/Project Representative shall be given a minimum of 48 hours' notice prior to taking any tests.

E. Testing shall be Contractor's responsibility and shall be performed at the Contractor's expense by a commercial testing laboratory operating in accordance with subparagraph C above.

F. Test results shall be furnished to the Engineer prior to continuing with associated or subsequent work.

1.12 PRE-INSTALLATION MEETINGS

A. Section 01 31 00 – Administrative Requirements: Pre-installation meeting.

B. Convene minimum one week prior to commencing work of this section.

1.13 PERFORMANCE REQUIREMENTS

A. Operation:

1. Provide 2 floats and one Ultrasonic Level transmitter approved by Owner/Operator. Set elevations in accordance with Drawings or as directed by Engineer. Set pumps to automatically switch operations from one pump to another after shut off of each pumping cycle.

B. Sound, Vibration, and Thermal Control – Dampen or suppress noise, absorb vibration, accommodate thermal expansion and stresses, and adjust or correct for misalignment in piping systems.

PART 2 – PRODUCTS

Materials and products used shall conform to one of the following and shall be as approved by the Engineer:

2.01 SEWER PIPE

A. PVC Pipe – Shall be polyvinyl chloride plastic (PVC) and shall meet all requirements of ASTM D 3034 SDR 26, except for depths less than three feet where ductile iron pipe must be installed. All pipe shall be suitable for use as a gravity sewer conduit. Provisions must be made for contraction and expansion at each

joint with a rubber gasket. Pipe sizes and dimensions shall be as shown below. All pipe shall be green or white in color with factory marked homing lines. Fittings shall meet the same specification requirements as pipe.

Nom. Size	Outside Diameter		Min. Wall Thickness
	Average	Tolerance	SDR-26
4	4.215	± 0.009	.162
6	6.275	± 0.011	.241
8	8.400	± 0.012	.323
10	10.500	± 0.015	.404
12	12.500	± 0.018	.481

Tests on PVC Pipe – Pipe shall be designed to pass all tests at 73 °F. (± 3 °F.).

B. Ductile Iron – Shall conform to ANSI A 21.50 (AWWA C 150), ANSI A 21.51 (AWWA C 151) and ASTM A 746. All pipe shall be Pressure Class 350 unless otherwise noted. All ductile iron pipes and fittings shall be bituminous coated on the outside and lined with Protecto 401 Ceramic Epoxy or equivalent on inside.

1. Coating on the outside shall be an asphaltic coating approximately 1 mil thick. Finished coating shall be continuous, smooth, neither brittle when cold or sticky when exposed to sun, and shall be strongly adherent to the iron.

2. Protecto 401 Ceramic Epoxy or equivalent interior lining shall conform to ASTM E 96, ASTM D 714, ASTM D 2794 and ASTM G 53. Interior of the pipe shall receive 40 mils nominal dry film thickness of epoxy. Lining application, inspection, certification, handling, and surface preparation of area to receive the protective coating shall be in accordance with manufacturer's specifications and requirements.

2.02 JOINTS - GRAVITY SYSTEM

A. Joints for Ductile Iron Pipe – Shall be slip-on rubber equivalent to "Fastite," "All-tite," or "Tyton."

B. Joints for PVC Pipe – Shall be integral wall bell and spigot with a rubber ring gasket. Joints shall conform to ASTM D 3212 and gaskets to ASTM F 477.

2.03 FORCE MAIN

A. P.V.C. – All pipe shall be green in color with factory marked homing lines. Pipe with diameter less than 4 inches shall conform to all requirements of ASTM D 2241, SDR 26, Class 160. Pipe 4 inches through 12 inches shall conform to all requirements of AWWA C900, DR 25, Pressure Class of 165 p.s.i. Pipe 14 inches through 18-inches shall conform to all requirements of AWWA C905 with C1 outside diameter, DR 25, with a pressure rating of 165 p.s.i. Joints shall be in accordance with ASTM D 3139.

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B. Ductile Iron pipe shall be in accordance with Paragraph 2.1-B and conform to ASTM A 377. Push-on-Joints shall be slip-on rubber equivalent to "Fastite," "All-tite," or "Tyton." Flanged joints shall conform to AWWA C 115. Gaskets shall conform to AWWA C 111.

C. Thrust blocking shall be sized as detailed on the construction drawings of 3,000 p.s.i. concrete. Blocking shall be provided at all bends deflecting 11-1/4º or more and bear directly against the undisturbed trench wall.

D. Restrained Joints – Restrained joints for pipe, valves and fittings shall be mechanical joints with ductile iron retainer glands equivalent to "Megalug" or push-on type joints equivalent to "Lok-Ring," "TR Flex," or "Super Lock" and shall have a minimum rated working pressure equal to the item restrained with a minimum safety factor of 2:1. Joints shall be in accordance with the applicable portions of AWWA C-111. Manufacturer of joints shall furnish certification, witnessed by an independent laboratory, stating joints furnished have been tested without signs of leakage or failure. Restrained joints shall be capable of being deflected after assembly.

2.04 STONE BACKFILL

A. Shall be graded crushed granite with the following gradation:

Square Opening Size	Percent Passing
1 inch	100%
3/4 inch	90 to 100%
3/8 inch	0 to 65%
No. 4	0 to 25%

2.05 SAND BACKFILL

A. Shall be clean sand free from clay and organic material. Not more than 10% shall pass the No. 100 sieve.

2.06 BORROW

A. Where it is determined sufficient suitable material is not available from the site to satisfactorily backfill pipe to at least two feet above top of pipe, Contractor, at no additional cost, shall furnish suitable sandy borrow material to accomplish requirements. Material shall not have more than 60% passing the No. 100 sieve, nor more than 20% passing a No. 200 sieve.

2.07 AIR RELEASE VALVE

A. Shall be designed for sewage service. The valve shall be constructed of a cast iron body, stainless steel or bronze trim, and stainless steel float. The inlet shall be two inches. The working pressure shall be 0 to 50 p.s.i. It shall be on automatic air valve.

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2.08 METAL DETECTOR TAPE

A. Will be installed above all pipe. Tape shall consist of 0.35 mils thick solid foil core encased in a protective plastic jacket resistant to alkalis, acids, and other destructive elements found in the soil. The lamination bond shall be strong enough so layers cannot be separated by hand. Total composite thickness shall be 5.0 mils. Foil core to be visible from unprinted side to ensure continuity. The tape shall have a minimum three-inch width and a tensile strength of 35 pounds per inch.

A continuous warning message indicating “sewer line” repeated every 16 inches to 36 inches shall be imprinted on the tape surface. Tape shall contain an opaque color concentrate designating color code appropriate to the line being buried (Sewer Line - Green).

2.09 MANHOLES

A. Masonry – Shall be new whole brick of good quality laid in masonry mortar or cement mortar made of one part Portland cement and two parts clean sharp sand. Every brick shall be fully bedded in mortar. Manholes shall conform to locations and details shown on the plans.

B. Precast Concrete – Shall be reinforced concrete constructed in accordance with ASTM C 478 and details shown on the plans "Precast Concrete Manholes." Coarse aggregate shall be granite stone. The joints shall be tongue and groove sealed with flexible gaskets or mastic sealant. Gaskets shall be O–Ring or equivalent to Type A or B "Tylox" conforming to ASTM C 443. Mastic shall be equivalent to "Ram–nek" with primer. Primer shall be applied to all contact surfaces of manhole joint at the factory in accordance with manufacturer's instructions.

C. Frames and Covers – Shall be cast iron equivalent to the following:

[Neenah Foundry Co. R–1668 Type "C" Lid]

D. Manhole Steps – Shall be equivalent to M.A. Industries, Type PS–1 or PS–2–PF. Steps shall be installed at the manhole factory and in accordance with recommendations of step manufacturer. Manholes will <u>not</u> be acceptable if steps are not installed accordingly.

E. Pipe Connections – Shall have flexible watertight joints at sewer main point of entry into the manhole. The joint shall be an EPDM or polyisoprene sleeve equivalent to "Kor–N–Seal.”

F. Coatings – New manholes shall have all interior surfaces coated with a factory applied acrylic polymer–base coating and sealant. The coating shall be ConSeal CS–55 manufactured by Concrete Sealants, New Carlisle, Ohio or an accepted equivalent. The coating shall be applied in three coats to achieve a total dry film thickness of at least 3.5 mils in accordance with manufacturer's recommendations. Surfaces shall be cleaned of all dust, form oils, curing compounds and other foreign matter prior to the coating application.

All new or existing manholes shall be coated with 125 wet film mils of Raven 405 ultra-high build epoxy or an accepted equivalent. The interior surfaces shall be cleaned and prepared according to manufacturer's recommendations.

2.10 PLANT DRAIN PUMP STATION

A. Shall be dual submersible pumps installed in a concrete wet well. Pumps shall be equivalent to Flygt or ABS conforming to characteristics shown on the drawings.

Pump Station

Flygt	CP 310L with 183 IMP
TDH	30
Pump Capacity	250
Maximum RPM	1,740
Phase	3
Voltage	230
Minimum HP	5
Minimum Efficiency	72

B. Wet Well Sections – Shall be precast reinforced concrete sections. The product design, performance, materials, manufacturing, handling, and installation shall conform to following references and project specifications:

ACI 318 – Building Code Requirements for Reinforced Concrete

ASTM C 39 – Compressive Strength of Cylindrical Concrete Specimens

ASTM C-478 – Precast Reinforced Concrete Manhole Sections

ASTM C 890 – Minimal Structural Design Loading for Precast Concrete Water and Wastewater Structures

ASTM C 891 – Installation of Underground Precast Concrete Utility Structures

ASTM C 913 – Precast Concrete Water and Wastewater Structures

1. Contractor or supplier shall provide for design of the precast structure. Each section of the structure shall be designed and manufactured for its individual depth, loading conditions (lateral, surcharge and hydrostatic), and opening requirements. All concrete in the precast structure shall have a minimum compressive strength of 4,500 p.s.i. after 28 days. Reinforcing steel shall comply with ASTM A 615 Grade 60 (min. fy = 60,000 p.s.i.). Bar bending and placement shall comply with the ACI latest standards.

2. Precast structure manufacturer shall have necessary equipment and facilities for proper manufacture of the sections and to perform compressive strength tests on concrete tests specimens. Test cylinders shall be made for each structure and test conducted in accordance with ASTM C 39, except compressive strength shall be equal to or greater than design of the concrete. Structure design computations, concrete mix

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design, and test reports certifying design strength has been achieved at the 28 day break shall be submitted to Engineer. Design of structure shall be performed by a Professional Engineer registered in the state of installation at Contractor's expense. The design parameters for a precast structure shall include:

a. Lateral load based on a water table at the surface using equivalent fluid pressure of 80 p.c.f. from surface grade down and a vehicle wheel load designation of HS20-44. Design live load for the top slab shall be 300 p.s.f. The precast concrete sections shall have a minimum wall thickness of six inches and minimum top and bottom slab thicknesses of eight inches. Actual thicknesses greater than minimum shall be as required by the loading conditions.

b. Access hatches in the top slab of wet-well structure shall be for clear opening dimensions indicated and have a load capacity of 300 p.s.f. The material shall be Aluminum Alloy 6063-T5 and T6, minimum 1/4 inch thick plate, flush-type lock with inside spoon handle. The frame shall be complete with hinged and hasp-equipped cover, upper guide holders, chain holders and cable holder. Chain and cable holders shall be stainless steel or aluminum. Frame shall be securely mounted above the pumps. The hatch covers shall be torsion-bar loaded for ease of lifting and shall have a safety-locking handle in open position. Access hatch shall be provided with a safety grate.

3. Contractor shall furnish and install guide bars for each pump to permit raising and lowering the pump. Guide bars shall be stainless steel and of adequate length and strength to extend from lower guide holders on the pump discharge connection to upper guide holder mounted on access frame.

4. The wet well shall be provided with sleeves, 24 inches below finished grade, for access of power and control conduits. The sleeves shall be of proper size and number to accommodate all necessary power and control conduits.

5. All interior concrete surfaces shall have either a minimum 125 mils coating of Raven 405, or an accepted equivalent.

6. The structure manufacturer shall prepare and submit six sets of shop drawings showing wall and slab thicknesses, structural reinforcing and opening locations. The manufacturer shall also provide design analyses and calculations to show all sections have been designed for burial depths shown on construction drawings as well as stresses incurred during transport, handling and installation. Calculations and analyses must be performed and sealed by a Licensed Professional Engineer from the state project is located and submitted for review. All shop drawings and design calculations shall be submitted to the Contractor for review. Contractor shall forward these documents to the Engineer. Such documents shall bear the stamp or written statement of Contractor indicating Contractor's review for completeness and receipt. Contractor shall be responsible for

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the accuracy of shop drawings and for their conformity to plans and specifications. Shop drawings with insufficient or incomplete data required to indicate compliance with these specifications are not acceptable and will be returned to the Contractor. Rejected shop drawings shall not relieve Contractor from completing the project within time allowed by Contract Documents.

C. Pump Design – Pumps shall be capable of handling raw, unscreened sewage with the capacity to pass three-inch diameter spheres. Pumping units shall be automatically connected to discharge piping when lowered into place on the discharge connection. The pumps shall be easily removable for inspection or service, requiring no bolts, nuts, or other fastening to be removed for this purpose, and no need for personnel to enter wet well. Each pump shall be fitted with a stainless steel chain of adequate strength and length to permit raising the pump for inspection and removal.

D. Pump Construction – The pump(s) shall be designed to pump sewage, storm water, heavy sludge, and other fibrous materials without injurious damage during operation. The lifting cover, stator housing and volute casing shall be of gray iron construction with all nuts, bolts, washers and other fastening devices coming into contact with sewage, constructed of stainless steel and protected by primer coat and a coat of rubber-asphalt or epoxy paint. The impeller shall be hard alloy gray iron construction, dynamically balanced, double shrouded, non-clogging design with a long thoroughfare and no acute angles.

1. The pump motor shall be of Class F Insulation, NEMA B design, watertight and positively oil cooled, filled with a transformer oil, equivalent to BP JS-HA, Shell Diala D, or housed in an air-filled watertight chamber. The pump motor shall be guaranteed to run in a totally, partially or non-submerged condition continuously for a period of 24 hours without injurious damages. Water cooled pumps shall not be considered equal. Before final acceptance, a field running test at job site demonstrating the ability to operate continuously for 24 hours under a non-submerged condition, shall be performed for all pumps being supplied, if required. The pump shall be provided with a tandem double mechanical seal running in an oil bath. The seals shall be of lapped tungsten carbide and welded to stainless steel retainers and held in contact by separate springs. Conventional double mechanical seals with a spring assembly between the rotating faces, requiring constant differential pressure to effect sealing and subject to penetration and opening by pumping forces shall not be considered equal to tandem seal specified and required. The pump shaft shall be of stainless steel and supported by a double row inboard bearing for axial thrust and a single row outboard bearing for radial thrust. The impeller shall be connected to a short sturdy shaft in order to minimize shaft deflection. Shaft shall not extend more than 2-1/2 times its diameter below the nearest support bearing.

2. The pump cable shall be of proper length to reach from pumps in wet well to control panel without any splices. Cable shall be the "SO" or hypalon jacketed SPC type and in compliance with industry standards for loads, resistance against sewage and of stranded construction. Cable shall enter the pump through a heavy duty entry assembly, which shall be

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provided with an internal grommet assembly to protect against leakage once secured and must have a strain relief assembly as part of standard construction. Power cable shall connect to a terminal board separating incoming service from pump motor, where if leakage occurs, terminal board will short out and not cause damage to the motor.

3. Each pump shall be supplied with a universal coupling which bolts to pump discharge flange and shall accept the discharge elbow provided by pump manufacturer. Seal of the pump at discharge flange shall be accomplished by a single downward linear motion of pump with entire weight of pump guided to and pressing against discharge connection. No part of pump shall bear directly on the sump floor and no rotary motion of pump shall be required for sealing. Sealing at the discharge shall be designed to insure a positive leakproof system and for ease of removal. Pump shall be guaranteed not to leak at the discharge flange.

E. Pump Test – Pump manufacturer shall perform following tests on each pump before shipment from the factory:

1. Megger the pump for insulation breaks or moisture.

2. Prior to submergence, the pump shall be run dry and checked for correct rotation.

3. Pump shall be run for 30 minutes in a submerged condition.

4. Pump shall be removed from test tank, meggered immediately for moisture; oil plugs removed for checking of upper seal and possible water intrusion of stator housing.

5. A written certified test report giving above information shall be supplied with each pump at the time of shipment.

6. All pump cable ends will then be fitted with a rubber shrink fit boot to protect cable prior to electrical installation.

F. Pump Controls – To synchronize the operation of pumps with variations of sewage level in wet well, Contractor shall provide utility approved ultrasonic transmitter to determine pump-on, lag pump on, pump-off, and high-level alarm conditions. Installation will be in accordance with the manufacturer's instructions.

1. Floats – Furnish two additional floats for high alarm and low alarm.

2. An alternator shall also be provided to change operation sequence of pumps at the completion of each pumping cycle. Provisions shall also be made for pumps to operate in parallel if level in wet well continues to rise above the "pump-on" cycle. Contractor shall furnish and install one automatic control center, equipped with individual disconnects, across-the-line magnetic starters, 3-phase, overload and phase protection, electrical alternator, automatic transfer to non-operating pump in event of overload in operating pump, overload reset, hand-off-automatic pump operation selector switch, 24-volt control circuit transformer, and terminal

board with connections for high-level alarm. All components shall be housed in a NEMA 4X enclosure. Control center shall be installed on a treated timber rack next to the station. Cables provided for pump feeders and pump controls shall be installed in conduit from control center to entrance point in wet well.

G. Alarm – A high-water alarm shall be supplied. A red flashing light shall be supplied in separate NEMA 4X enclosure for mounting at the control box. An audible alarm consisting of a weatherproof bell with automatic reset silencer switch and signal light shall be installed in addition to the flashing red light alarm.

H. Shop Drawings:

1. Contractor shall submit for review by Engineer a complete schedule and data of materials and equipment to be incorporated in the work. Submittals shall be supported by descriptive material, such as catalogs, diagrams, performance curves, and charts published by the manufacturer, to show conformance to specification and drawing requirements. Model numbers alone will not be acceptable. Complete electrical characteristics shall be provided for all equipment.

2. All shop drawings shall be completely checked and marked accordingly with Contractor's stamp prior to submitting drawings to the Engineer for review. Shop drawings with insufficient or incomplete data required to indicate compliance with these specifications are not acceptable and will be returned to the Contractor. Where shop drawings are "Furnished as Corrected," the reviewer has noticed deficiencies in compliance with contract specifications and drawings. It is understood corrections indicated will be incorporated by Contractor in the final product, operation and maintenance manuals and shop drawings submitted at completion of project. Rejected shop drawings shall not relieve Contractor from completing the project within time allowed by contract documents.

I. Pump Warranty – The pump manufacturer shall warrant pumps being supplied to Owner against defects in workmanship and materials for a period of five years under normal use, operation, and service. In addition, manufacturer shall replace certain parts which become defective through normal use and wear on a progressive schedule of cost for a period of five years. Parts included are the mechanical seal, impeller pump housing, wear ring, and ball bearings. The warranty shall be in published form and apply to all similar units.

J. Operation and Maintenance Manual – The pump manufacturer shall furnish Owner with a minimum of six manuals for pumps installed.

K. Provide Scada System to integrate into the overall plant Scada system. Provide equipment, conduit, and wiring as need to prove a fully functional system.

2.11 EFFLUENT PUMP STATION

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Shall be vertical turbine installed in a concrete wet wall.

A. Pump and Driver Requirements

1. Type of Installation – The work shall include furnishing, installing, and testing line shaft vertical turbine pumping units and their appurtenances as indicated. Pumps shall be utilized and installed as described below. Line shaft lubrication shall be potable water.

2. Pump Drivers – Pumps shall have the type of drive units indicated.

B. Pump Performance

Pumps shall be capable of discharging quantities of water at maximum pump speed and total pump head with the minimum efficiency indicated. Total pump head in feet shall consist of the pumping level below datum and the static and friction head above datum at design capacity.

PUMPING REQUIREMENTS – PUMPS #1 & #2

Pump Conditions (Single Pump Operating)	660 GPM @ 170' TDH
Pump Conditions (Two Pumps Operating)	1,125 GPM @ 190' TDH
Minimum Shutoff Head	225 Ft
Maximum Nominal Speed	1,800 RPM
Minimum Pump Efficiency	75%
Maximum NPSH Required	16 Ft
Manufacturer	Peerless
Min. HP	40
Phase	3
Voltage	460

C. Line Shaft Vertical Turbine Pumps

Line shaft vertical turbine pumps shall be constructed in accordance with AWWA E101 except as modified. Pumps shall be designed for flanged discharge and the pump setting or location of the pump suction shall be as indicated.

1. Pump Head Assembly

Pump head assembly shall consist of the pump baseplate, the discharge head, and the driver. Head assemblies shall be of low, rigid construction arranged for bolting to concrete foundations and shall be provided with at least two eyebolts, cast lugs, or other means of securing slings to facilitate setting and lifting. Pump discharge head and baseplate shall be capable of withstanding all end and side thrusts imposed by the pump during operation and have adequate strength to resist vibration at any operating speed.

a. Pump Baseplate

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Pump head baseplate shall be steel and shall serve as a sole plate for mounting the discharge head assembly.

b. Discharge Head

Discharge head shall be cast iron with 125-pound flanges. Flanges shall be designed for standard pipe connections conforming to ASME B16.1 and ASME B16.5. Surface-type discharge heads shall be designed for mounting on the baseplate or cast integrally with the baseplate. Discharge head shall be provided with a packed stuffing box with bronze lantern ring, a split gland follower, bronze follower nuts, and a grease lubricator. Discharge head shall be designed to prevent contamination of the well from the surface, and shall accommodate the required driver assembly. Space shall be provided for access to the coupling between the pump shaft and drive shaft. Pipe taps shall be provided on the discharge head as required for discharge gauge connections. Discharge head interior and exterior shall be coated with epoxy coating with a DFT of 10-14 mil.

2. Water-Lubricated Column and Shaft Assembly

Each section of the discharge column shall consist of a flanged type column pipe, line shaft, bronze bearing retainers with rubber bearings spaced not more than 10 feet on centers. Line shaft shall be Type 416 stainless steel with threaded couplings. Line shaft should be sized to operate pump without excessive distortion or vibration. Type 304 stainless steel shaft sleeves shall be furnished at each bearing location. Column pipe shall be ASTM Grade 53 B steel pipe with 150 LB flanged connections. Column pipe must be a minimum of six-inch diameter. Column pipe interior and exterior shall be coated with epoxy coating with a DFT of 10-14 mil.

3. Pump Bowl Assembly

Pump bowl assembly shall include the pump bowl, pump impeller, and the pump shaft and bearings, and may be of single stage or multistage configuration. Pump bowl exterior shall be coated with epoxy coating with a DFT of 10-14 mil.

a. Pump Bowls

Bowls shall be of close-grained cast-iron having a minimum tensile strength of 30,000 pounds per square inch, free from blowholes, sandholes, and other faults, and shall have integrally-cast vanes with smooth, streamlined water passageways. All bowl fasteners shall be Type 304 stainless steel.

b. Impellers

Impellers shall be carefully finished with smooth water passageways and shall not load the prime mover beyond the

nameplate rating over the entire performance range of the pump. Impellers shall be of the enclosed type. Impellers shall be statically and dynamically balanced. Impellers shall be fabricated from bronze.

4. Pump Shafts

Shafts shall be of Type 416 stainless steel of not less than 12% chrome content, capable of transmitting the required thrust in both direction, and the total torque of the unit.

5. Bearings

Intermediate bowl shall have dual bowl bearing, utilizing one water lubricated bronze bearing and one fluted rubber bearing.

6. Basket Strainer

Suction bell shall be fitted with a Type 316 stainless steel basket strainer. Basket Strainer shall be made with integral vortex suppression baffles.

D. Manufacturer's Field Services

1. Service Center

a. The pump manufacturer shall have a factory authorized service center within 5.0 hours driving time of the project site to perform complete repair of the pump unit. The service center should have adequate equipment, inventory, and personnel to perform complete repairs and rebuilds to the pump unit. The service center shall be capable of providing 24 – 48 hours turnaround of line shaft and bearing repairs, from the time of notification of needed repairs to pumps being reinstalled and placed back in operation.

b. The service center shall have an established emergency/afterhours service protocol in place and operating 24 hours a day, 7 days a week, including nights, weekends, and holidays. This protocol shall be an established protocol and designed to specifically address the emergency needs of Municipal Customers. The service center shall have complete push-pull equipment and crews which can be onsite within eight hours of notification. The service protocol shall incorporate a 24 hours a day, 7 days a week call-in number which must be answered within 15 minutes by duty personnel with the authority to mobilize men and machinery. This capability will be demonstrated to the Engineer's and Owner's satisfactory prior to submittals being approved. Organization tables, mobilization authorities, and protocols shall be submitted for review to the Engineer. The service center shall have a minimum of three service trucks with hoists and not less than three trained pump crews which can be mobilized at any time to ensure availability. The service center shall have full machining capability as needed to make and/or repair pumps of the size on this project.

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2. Start Up Service – Pump manufacturer shall have a qualified Field Representative present for startup and training of the station. A minimum of one eight-hour day shall be provided.

2.12 CHECK VALVES

A. Shall be designed for sewage service. The valve shall be cast iron and bronze fitted. The valve shall be a spring and lever type with neoprene seat and O-Ring seals on a stainless steel valve pin, for pipes three inches and larger in diameter. For check valves smaller than three inches, the valve shall be a fully ported 150 p.s.i. rated ball check valve with a corrosion resistant phenolic base and a rubber seat. Check valve shall be of full waterway design for quiet operation and with a flow area through the valve equal to or exceeding flow area of pipe to which it is installed.

2.13 PLUG VALVES

A. Shall be fully ported and of the same diameter as pipes to which they are attached. They shall have semi-steel bodies, all metal plugs, stainless steel bearings, and be equivalent to DeZurik Series 100 eccentric valves, lever operated. All valves six inches and larger shall be equipped with gear actuator and handwheel.

2.14 FLOW METER

A. Flow Meter shall be as specified elsewhere.

2.15 PRODUCT REVIEW

A. Contractor shall provide the Engineer with a complete description of all products before ordering. Engineer will review all products before they are ordered by Contractor.

PART 3 – EXECUTION

3.01 CONSTRUCTION OBSERVATION

A. The pump station operation shall be tested by Contractor under the direction of Engineer. Engineer or Project Representative will have the right to require any portion of work be completed in their presence. If work is covered up after such instruction, it shall be exposed by Contractor for observation. However, if Contractor notifies Engineer such work is scheduled and Engineer fails to appear within 48 hours, the Contractor may proceed. All work completed and materials furnished shall be subject to review by the Engineer or Project Representative. All improper work shall be reconstructed. All materials not conforming to requirements of specifications shall be removed from the work upon notice being received from Engineer for rejection of such materials. Engineer shall have the right to mark rejected materials to distinguish them as such.

B. Contractor shall give the Project Engineer or Project Representative a minimum of 48 hours notice for all required observations or tests.

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C. It will also be required by Contractor to keep accurate, legible records of the location of all appurtenances. These records will be prepared in accordance with "Record Data and Drawings" paragraph in the Special Conditions. Final payment to the Contractor will be withheld until all such information is received and accepted.

3.02 PARTIAL ACCEPTANCE OF THE WORK

A. Owner reserves right to accept and use any part of the work. Engineer shall have power to direct on what line the Contractor shall work and order thereof.

3.03 RECORD DATA

A. It will be required of the Contractor to keep accurate, legible records, locating all as-built conditions. These records will be made available to Engineer before final review for incorporation into the Engineer's Record Drawings. Final payment to the Contractor will be withheld until all such information is received and accepted.

3.04 AIR RELEASE VALVE

A. The installation of valve shall be in accordance with standard drawings.

3.05 PUMPING STATION

A. Install pumps including fittings, brackets, discharge piping, check valve to basin rail assembly, plug valve, and lifting device according to manufacturer's recommendation.

B. Contractor shall provide, at minimum, spare parts to include but not limited to:

1. One Spare VFD as a pump starter.
2. One of each seal assemblies.
3. One complete set of bearings.
4. One set of wear rings.
5. One of each type relay.
6. One pump alternator.
7. One float switch with cable.
8. One of each type pilot light.
9. One box of each type lamp.

3.06 STATION STARTUP, INITIAL TESTING, AND OPERATION

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A. Notify Engineer personnel five working days prior to flow rate testing.

B. Hydraulically test station to performance requirements.

C. Correct failures during test by repairing or replacing malfunctioning parts or equipment of faulty workmanship, regardless of cause, within 24 hours.

D. After correcting failures caused by defective equipment, material, or faulty workmanship, retest until failures are eliminated.

E. Confirm general sequencing of pump and float operations at basin and control panel are in accordance with performance requirements and Utility requirements.

F. Adjust pumps and control panel system to conform to performance requirements.

G. Document and certify startup results in start-up report.

3.07 MANUFACTURER'S FIELD SERVICE

A. Furnish factory trained representative and field technical assistance during the following periods of pumping station installation:

1. Unloading of station materials and components.

2. Start-up, testing, and demonstration of station systems pump, and control panel.

3.08 MANHOLES

A. Manholes shall be constructed where shown on the drawings or where directed by Engineer. The channel in bottom of manholes shall be smooth and properly rounded. Special care must be exercised in laying the channel and adjacent pipes to grade. Manhole top elevations shall be greater than or equal to the 50 year flood elevation, unless watertight covers are provided. Tops of manholes outside of roads shall be built to grades one inch above ground surface in developed areas and six inches above ground surface in undeveloped areas unless otherwise shown on the plans. Manholes in roads shall be built to grades designated by the Engineer. Manhole sections with either honeycomb defects; exposed reinforcing; broken/fractured tongue or groove; or cracked walls will be subject to rejection by Engineer for use on the project. When mastic sealant is used, improperly applied primer will also be cause for rejection.

B. No leaks in any manhole will be acceptable. All repairs made from inside the manhole shall be made with mortar composed of one part Portland cement and two parts clean sand. The mixing liquid shall be straight bonding agent equivalent to "Acryl 60."

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3.09 STONE BEDDING

A. Where, in the Engineer's or Geotechnical Consultant's opinion, subgrade of pipe trench is unsuitable material, Contractor shall remove unsuitable material to a depth determined by Engineer or Geotechnical Consultant and furnish and place stone backfill in trench to stabilize subgrade. Presence of water does not necessarily mean stone backfill is required. If well points or other types of dewatering will remove the water, Contractor shall be required to completely dewater trench in lieu of stone backfill. Stone bedding will be limited to areas where well pointing and other conventional methods of dewatering will not produce a dry bottom. Stone shall be placed four feet wider than the outside diameter of pipe. The pipe shall be carefully bedded in stone as specified, or in accordance with manufacturer's recommendations.

3.10 SAND BEDDING

A. Where, in the Engineer's or Geotechnical Consultant's opinion, character of soil is unsuitable for pipe bedding, even though dewatered, additional depth of excavation as determined by Engineer or Geotechnical Consultant shall be made and replaced with clean sand furnished by Contractor.

3.11 DEFLECTION

A. It is the Contractor's responsibility to assure backfill is sufficient to limit pipe deflection to no more than 5%. When flexible pipe is used, a deflection test shall be made by Contractor on the entire length of installed pipeline, not less than 30 days after completion of all backfill and placement of any fill. Deflection shall be determined by use of a deflection device or by use of a spherical, spheroidal, or elliptical ball, a cylinder, or circular sections fused to a common shaft. Ball, cylinder, or circular sections shall have a diameter, or minor diameter as applicable, of 95% of the inside pipe diameter. The ball, cylinder, or circular sections shall be of a homogeneous material throughout, shall have a density greater than 1.0 as related to water at 39.2 ºF, and shall have a surface brinell hardness of not less than 150. The device shall be center bored and through bolted with a 1/4 inch minimum diameter steel shaft having a yield strength of 70,000 p.s.i. or more, with eyes at each end for attaching pulling cables. The eye shall be suitably backed with flange or heavy washer; a pull exerted on opposite end of shaft shall produce compression throughout remote end of ball, cylinder, or circular section. Circular sections shall be spaced so distance from the external faces of front and back sections shall equal or exceed diameter of circular section. Failure of the ball, cylinder, or circular section to pass freely through a pipe run, either by being pulled through by hand or by being flushed through with water, shall be cause for rejection of individual run. When a deflection device is used for the test in lieu of a ball, cylinder, or circular sections described, such device shall be acceptable to Engineer prior to use. Device shall be sensitive to 1.0% of diameter of pipe being measured and shall be accurate to 1.0% of indicated dimension. Installed pipe showing deflections greater than 5% of the normal diameter of pipe shall be retested by a run from opposite direction. If retest also fails, the suspect pipe shall be repaired or replaced at no cost to Owner.

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3.12 LEAKAGE

A. In no stretch of sewer between any two adjoining manholes shall infiltration/exfiltration exceed 25 gallons per day per inch of pipe diameter per mile of pipe. In case leakage exceeds this amount, the sewer shall not be accepted until such repairs and replacements are made to comply with above requirements. Such corrections will be made at the Contractor's expense. All visible leaks shall be repaired, regardless of the amount of leakage.

B. Lines shall be tested for leakage by low-pressure air testing, infiltration tests, or exfiltration tests, as appropriate. Low-pressure air testing for PVC pipe shall be as prescribed in ASTM F 1417. Prior to infiltration or exfiltration tests, trench shall be backfilled up to at least the lower half of pipe. If required, sufficient additional backfill shall be placed to prevent pipe movement during testing, leaving the joints uncovered to permit inspection. Visible leaks encountered shall be corrected regardless of leakage test results. When water table is two feet or more above top of pipe at upper end of pipeline section to be tested, infiltration shall be measured using a suitable weir or other device acceptable to Engineer. When Engineer determines infiltration cannot be properly tested, an exfiltration test shall be made by filling the line to be tested with water so a head of at least two feet is provided above both water table and top of pipe at upper end of pipeline to be tested. The filled line shall be allowed to stand until pipe has reached its maximum absorption, but not less than four hours. After absorption, the head shall be re–established. The amount of water required to maintain this water level during a two-hour test period shall be measured. Leakage as measured by either the infiltration test or exfiltration test shall not exceed 25 gallons per inch diameter per mile of pipeline per day. When leakage exceeds the maximum amount specified, satisfactory correction shall be made and retesting accomplished. Testing, correction, and retesting shall be made at no additional cost to the Owner.

C. The Contractor shall furnish equipment and plugs and subject force mains to hydrostatic tests at 100 p.s.i. for a period of two hours. Any leaks shall be located and repaired. Each section tested shall be slowly filled with water, care being taken to expel all air from the pipes. No pipe installation will be accepted until leakage during pressure test is less than the number of gallons listed for each 1000–feet of pipe tested:

6 inches & less – 0.9 gallons	12 inches – 1.80 gallons
8 inches – 1.20 gallons	14 inches – 2.10 gallons
10 inches – 1.50 gallons	16 inches – 2.40 gallons

3.13 CLEANING AND ACCEPTANCE

A. Before acceptance of sewer system, it shall be tested and cleaned to the satisfaction of Engineer. Where any obstruction is met, Contractor will be required to clean sewers by means of rod and swabs or other instruments. The pipe line shall be straight and show a uniform grade between manholes. The Engineer shall check lines by lamping or other methods to determine final acceptance.

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3.14 CLOSING PIPE

A. When work or pipe installation is suspended, either for the night or at other times, end of sewer must be closed with a tight cover. Contractor will be held responsible for keeping the sewer free from obstruction.

3.15 PUMPING STATIONS

A. The precast sections shall be carefully handled and placed in position undamaged. Spalled areas, cracks, or exposed reinforcing in any section shall be cause for rejection of a section. Damaged elements shall be promptly removed from the job–site.

The structure shall be installed plumb and level by Contractor on a prepared, evenly distributed and level, minimum 12-inch-thick crushed–stone bed. Joints between sections shall be sealed with butyl–rubber or neoprene sealant. Asphaltic–based material or similar products shall not be used. The sealant shall be applied in accordance with sealant manufacturer's recommendation. Leakage through joints or around pipes will not be acceptable. Grout used at construction joints and around pipes shall be Five Star brand non–shrink grout or an acceptable equivalent.

Excavation shall be accomplished in a manner as required to protect adjacent property and utilities and for safety. Backfilling shall be accomplished as soon as practicable after the structure has been placed and sealed. Backfilling shall be achieved by placing material in equal lifts (maximum two feet) and compacting each lift to maintain stability and plumbness of the structure. Backfill material shall be a select granular material with a maximum plasticity index (P.I.) of 12. Compaction shall be accomplished by means of mechanical tamping to 98% of maximum laboratory density at optimum moisture when tested by ASTM D 6938. During backfilling operation and until its completion, the wet well sections shall be maintained in an absolute plumb position. To prevent structure from possibly becoming buoyant in hydrostatic or flooded conditions, Contractor shall take necessary steps to avoid flotation of the structure.

Drawings indicate the general arrangement and location of electrical equipment, conduit, piping, transformer, and generator. Installation and location of these items shall be coordinated with the pump station operating personnel.

3.16 FORCE MAIN

A. Ductile Iron Force Main shall be installed in accordance with AWWA C 600.

B. PVC Force Main shall be installed in accordance with ASTM D 2774.

C. Crossings with water mains shall conform to South Carolina Department of Health and Environmental Control's Bureau of Water Standards for Wastewater Facility Construction: Regulation 61–67.

END OF SECTION

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SECTION 33 41 01

STORM DRAIN PIPING

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SECTION 33 41 01

STORM DRAIN PIPING

PART 1 – GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section and any supplemental Data Sheets:

1. American Association of State Highway and Transportation Officials (AASHTO):

   a. M36M, Standard Specification for Corrugated Steel Pipe, Metallic–Coated, for Sewers and Drains.

   b. M 190M, Standard Specification for Bituminous Coated Corrugated Metal Culvert Pipe and Pipe Arches.

   c. M196M, Standard Specification for Corrugated Aluminum Pipe for Sewers and Drains.

2. ASTM International (ASTM):

   a. C14, Standard Specification for Concrete Sewer, Storm Drain, and Culvert Pipe.

   b. C76, Standard Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe.

3. South Carolina Department of Transportation Standard Specifications, latest edition (SCDOT Standard Specifications.)

1.02 SUBMITTALS

A. Informational Submittals: Manufacturer's Certification of Compliance.

PART 2 – PRODUCTS

2.01 PIPE AND FITTINGS

A. As specified in the Data Sheets following "End of Section" and in accordance with SCDOT Standard Specification.

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PART 3 – EXECUTION

3.01 INSTALLATION OF PIPE, FITTINGS, AND APPURTENANCES

A. General:

1. Pipe laying shall proceed upgrade with spigot ends pointing in direction of flow.

2. Excavate bell holes at each joint to permit correct assembly and inspection of entire joint.

3. Pipe invert may deviate from line or grade up to 0.1 foot provided that finished pipe line will present a uniform bore, and such variation does not result in a level or reverse sloping invert, or less than minimum slope shown.

4. Pipe bedding shall form continuous and uniform bearing and support for pipe barrel between joints. Pipe shall not rest directly on bell or pipe joint.

5. Prevent entry of foreign material into gasketed joints.

6. Plug or close off pipes that are stubbed off for manhole, concrete structure, or for connection by others, with temporary watertight plugs.

7. Storm pipes shall be installed in accordance with SCDOT Standard.

B. Concrete Closure Collars: Only use concrete closure collars where shown or authorized by Engineer.

3.02 SUPPLEMENTS

A. The supplement listed below is part of this Specification.

1. Data Sheet:

Number	Title
–.05	Reinforced Concrete

DATA SHEET

SECTION 33 41 01.05 REINFORCED CONCRETE	
Item	**Description**
Pipe	In accordance with South Carolina Department of Transportation Standard Specification for reinforced concrete pipe. Class III and Class IV.

END OF SECTION

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SECTION 40 05 15

PIPE HANGERS AND SUPPORTS

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SECTION 40 05 15

PIPE HANGERS AND SUPPORTS

PART 1––GENERAL

1.01 DESCRIPTION

A. SCOPE:

1. GENERAL: This section specifies hangers and supports for all exposed piping systems specified in Section 40 27 05. This section does not include pipe supports for fire sprinkler systems or seismic restraints.

2. SCOPE OF CONTRACTOR DESIGN: The Contractor shall provide the services of a "Design Professional" as specified in paragraph 40 27 05–1.01 A to conduct all necessary piping and support design for exposed piping.

   Whether a design or general arrangement is shown or not, Contractor's Design Professional shall design all pipe supports, anchorage, restraints and expansion control, as specified. Where a conflict arises, Contractor's Design Professional shall present any conflict to Construction Manager for resolution.

   The Design Professional's work shall incorporate design criteria and other conditions as specified herein, in related sections and as shown on the drawings.

   Additional requirements are specified in related sections.

3. SCOPE OF WORK BY DESIGN ENGINEER: Design Engineer has undertaken design details for supports and anchors for: selected discharge and intake manifolds; selected special installation requirements; and, selected piping 48–inches and larger. Contractor's Design Professional shall incorporate these features into the Contractor's design.

   Where shown, Design Engineer has also provided guidance in the form of general arrangements that may include specific types of supports or anchorage details. In addition, allowable anchor points and load capacities for potential support structures are shown or otherwise described herein.

B. OPERATING CONDITIONS:

The hangers and supports specified in this section are provided to resist pipe loads occurring primarily in the downward (gravity) direction. For the purpose of pipe hanger and support selection, this section establishes pipe support classifications based on the operating temperatures of the piping contents. Pipe support classifications are as follows:

1. Hot Systems
   A – 1. 120 degrees F to 450 degrees F
   A – 2. 451 degrees F to 750 degrees F
   A – 3. Over 750 degrees F

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2. Ambient Systems
   B. 60 degrees F to 119 degrees F

3. Cold Systems
   C – 1. 33 degrees F to 59 degrees F
   C – 2. –20 degrees F to 32 degrees F

C. HANGER AND SUPPORT SELECTION:

The Contractor shall cause the pipe hangers and supports to be designed and selected by the Design Professional retained under the provisions of paragraph 40 27 05–1.01 A 2.. This provision, however, shall not relieve the Contractor of overall responsibility for this portion of the work. Hanger and support selection shall be based on the following:

1. The Contractor shall select pipe hangers and supports as specified in the project manual. Selections shall be based upon the pipe support classifications specified in MSS–SP 69, the piping insulation thickness specified in Section 40 27 05.09, and any special requirements which may be specified in the project manual.

2. The Contractor shall review the piping layout in relation to the surrounding structure and adjacent piping and equipment before selecting the type of support to be used at each hanger point.

3. Where a particular pipe support arrangement is shown, a design incorporating that arrangement shall be used.

4. Where a particular pipe support design is shown, that design shall be used.

5. Pipe supports shall be spaced such that pipe span deflections do not exceed 0.1–inch.

6. Pipe support design shall incorporate applicable criteria of ASME or other recognized standard.

7. The pipe hanger and support system shall be coordinated with the seismic restraint system specified under Section 40 05 15.10.

8. Hangers and supports shall withstand all static and specified dynamic conditions of loading to which the piping and associated equipment may be subjected. As a minimum, consideration shall be given to the following conditions:

   a. Weights of pipe, valves, fittings, insulating materials, suspended hanger components, and normal fluid contents.

   b. Weight of hydrostatic test fluid or cleaning fluid if normal operating fluid contents are lighter.

   c. Reaction forces due to test and operational conditions.

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d. Reaction forces due to the operation of safety, relief, or other valves.

e. Wind, snow or ice loadings on outdoor piping.

f. Supports shall be designed to prevent transfer of the weight of piping, valves and piping appurtenances to equipment piping connections. All supports adjacent at equipment connections to piping systems shall have provisions for vertical and horizontal adjustment. Two flexible piping connections not less than one pipe diameter apart shall be provided between piping supports and any equipment piping connection.

9. Hangers and supports shall be sized to fit the outside diameter of pipe, tubing, or, where specified, the outside diameter of insulation.

10. Where negligible movement occurs at hanger locations, rod hangers shall be used for suspended lines, wherever practical. For piping supported from below, bases, brackets or structural cross members shall be used.

11. Hangers for the suspension of size 2 1/2 inches and larger pipe and tubing shall be capable of vertical hanger component adjustment under load.

12. The supporting systems shall provide for and control the free or intended movement of the piping including its movement in relation to that of connected equipment.

13. Where there is horizontal movement at a suspended type hanger location, hanger components shall be selected to allow for swing. The vertical angle of the hanger rod shall not, at any time, exceed 4 degrees.

14. There shall be no contact between a pipe and hanger or support component of dissimilar metals. Prevent contact between dissimilar metals when supporting copper tubing by use of copper–plated, rubber, plastic or vinyl coated, or stainless steel hanger and support components.

15. Stock hanger and support components shall be used wherever practical.

16. Fiberglass framing channel shall be provided where specified.

The following structural criteria shall also be applied:

1. Unless otherwise specified, existing pipes and supports shall not be used to support new piping.

2. Unless otherwise specified, pipe support components shall not be attached to pressure vessels.

3. Where critical support load requirements have been identified, limiting structural load requirements are shown.

4. Pipe support hangers, brackets etc. shall be of suitable capacity and shall be appropriate to the individual structural member that is used to support

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the pipe.

5. The structural integrity of existing and new members shall in no way be impacted by the placement of connections for pipe supports. For example, the tension reinforcement in reinforced concrete members shall not be impacted in any way by the placement of fasteners for pipe supports.

6. Spacing and arrangement of hangers supporting pipe shall be provided in such a manner that the loads from the pipes on existing and new structural members shall be quasi–uniform. These quasi–uniform loads shall not exceed the allowable design loads for mechanical equipment as shown on existing (not necessarily contract) drawings and as listed under Design Live Loads in the General Notes.

7. For new construction, unless otherwise shown, pipe may be supported from nearest structural element (floor, ceiling, or wall). The Design Loads for mechanical equipment, as listed in the General Notes sheet of the Structural drawings shall not be exceeded.

8. The loads and specific attachment requirements for pipe supports on new concrete Tees shall be coordinated with the Tee manufacturer and incorporated into the design of the Tees.

9. Unless otherwise specified, pipe supports from existing Tees or other roof types shall not be constructed without an evaluation of capacity and appropriate design from Contractor's Design Professional.

The following, project–specific criterion shall also be applied:

1. The spacing for pipe hangers shall not be less than 5 feet and shall not exceed 375 lbs of load for all existing pre–cast, Double Tee roof elements. For hangers off flanges of existing Tees, a washer shall be provided having minimum dimensions of 1/4 inch thick by 4 inch long and 4 inch wide. The design and projection of those hangers above the roof shall be coordinated with the architectural roofing system.

2. For sodium hydroxide systems, pipe supports shall be 60 percent closer than the maximum spacing indicated for plastic piping for water service.

1.02 QUALITY ASSURANCE

A. REFERENCES

This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective

date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced.

Reference	Title
AISC Manual of Steel Construction	American Institute of Steel Construction, Manual of Steel Construction, Allowable Stress Design – 9th Ed.
FEDSPEC WW–H–171e–78	Hangers and Supports, Pipe
MFMA–2–91	Metal Framing Standards Publication
MSS SP–69–91	Pipe Hangers and Supports – Selection and Application
MSS SP–58–93	Pipe Hangers and Supports – Materials, Design and Manufacture

B. DESIGN:

The Contractor shall cause the design of pipe hanger and support systems to be developed in conjunction with preparation of the design seismic restraints and expansion control system by the Design Professional selected in accordance with Paragraph 40 27 05–1.01 A. The pipe system drawings specified in paragraph 40 27 05–2.04 shall show the hanger and support locations as well as the details of the seismic restraints and expansion control systems. The pipe hanger and support design drawings and calculations shall be prepared and signed by the design professional and shall bear the Design Professional's registration seal.

PART 2––PRODUCTS

2.01 ACCEPTABLE PRODUCTS

Standard pipe supports and components shall be manufactured by B–Line, Carpenter & Patterson, Kin–Line, Grinnell, Michigan, Pipe Shields Incorporated, Superstrut, Unistrut, or equal. Pipe support components shall conform to the requirements of MSS SP–69 and FEDSPEC WW–H–171e. Pipe support materials shall conform to the requirements of MSS SP–58. Metal framing system components shall conform to the metal framing manufacturers' Association Standard MFMA–2.

2.02 MATERIALS

A. GENERAL:

Unless otherwise specified, pipe hangers and supports, structural attachments, fittings and accessories shall be hot–dip or mechanically galvanized after fabrication. Nuts, bolts and washers may be zinc–plated except for those subject to moisture or corrosive atmosphere, as specified in paragraph 16000–1.05 B as shown on the drawings, which shall be type FRP or 304 stainless steel. Exterior pips supports shall be FRP or stainless steel.

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B. PIPE HANGERS AND SUPPORTS:

Pipe hangers and supports of dissimilar metals than pipe shall be insulated. Pipe hangers and supports shall support pipe in the manner recommended by the pipe manufacturer and/or applicable building or piping codes.

C. RACK AND TRAPEZE SUPPORTS:

Unless otherwise specified, trapeze and pipe rack components shall have a minimum steel thickness of 12 gage, with a maximum deflection 1/240 of the span.

D. STRUCTURAL ATTACHMENTS:

1. TYPE A – MALLEABLE IRON CONCRETE INSERT: Concrete inserts shall be malleable iron and comply with MSS and FEDSPEC Type 18. Grinnell Fig. 282, Carpenter & Patterson Fig. 108, or equal.

2. TYPE B – SIDE BEAM BRACKET: Bracket shall be malleable iron and comply with MSS Type 34 and FEDSPEC Type 35. Grinnell Fig. 202, B–Line B3062, or equal.

3. TYPE C – MALLEABLE BEAM CLAMP WITH EXTENSION PIECE: Clamp and extension piece shall be malleable iron, tie rod shall be steel. Beam clamp shall comply with MSS and FEDSPEC Type 30. Grinnell Fig. 218 with Fig. 157 extension piece, B–Line B3054, or equal.

4. TYPE D – STEEL BEAM CLAMP WITH EYE NUT: Beam clamp and eye nut shall be forged steel. Configuration and components shall comply with MSS and FEDSPEC Type 28. Grinnell Fig. 292, Carpenter & Patterson Fig. 297, or equal.

5. TYPE E – FRAMING CHANNEL POST BASE: Post bases shall be carbon steel, of standard design manufactured by framing channel manufacturer. Single channel: Unistrut P2072A, B–Line B280, or equal. Double channel: Unistrut P2073A, B–Line B281, or equal.

6. TYPE F – WELDED BEAM ATTACHMENT: Beam attachment shall be carbon steel and comply with MSS and FEDSPEC Type 22. B–Line B3083, Grinnell Fig. 66, or equal.

7. TYPE G – WELDED STEEL BRACKET: Bracket shall be carbon steel and comply with MSS Type 32 and FEDSPEC Type 33 for medium welded bracket. Heavy welded bracket shall comply with MSS Type 33 and FEDSPEC Type 34.

8. TYPE H – CAST IRON BRACKET: Bracket shall be cast iron, Carpenter & Patterson Fig. 340, or equal.

9. TYPE J – ADJUSTABLE BEAM ATTACHMENT: Beam attachment shall be carbon steel, Carpenter & Patterson Fig. 151, B–Line B3082, or equal.

10. TYPE K – DOUBLE CHANNEL BRACKET: Wall channel shall be single channel framing channel as specified in paragraph 40 05 15–2.02 E.5. Cantilever

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bracket shall be a carbon steel double framing channel assembly, Unistrut P2542 through P2546, B–Line B297–12 through B297–36, or equal.

11. TYPE L – SINGLE CHANNEL BRACKET: Wall channel shall be single channel framing channel as specified in paragraph 40 05 15–2.02 E.5. Cantilever bracket shall be a carbon steel single framing channel assembly, Unistrut P2231 through P2234, B–Line B198–6, B198–12, B196–18 and B196–24, or equal.

12. TYPE M – WALL MOUNTED CHANNEL: Wall channel shall be single channel framing channel as specified in paragraph 40 05 15–2.02 E.5.

13. TYPE N – PIPE STANCHION FLOOR ATTACHMENT: Baseplate shall be carbon steel with 1/2 inch minimum thickness. Anchor bolt holes shall be 1/16 inch larger than the anchor bolt diameter. The space between the baseplate and the floor shall be filled with nonshrink grout.

14. TYPE Q – CONTINUOUS CONCRETE INSERTS: shall be 1 5/8 by 1 3/8 Channel, cold formed 12 Ga. steel conforming to ASTM A 1001, stainless steel GR 33 or ASTM GR 33 A., hot dip galvanized conforming to ASTM A123 or A153, UNISTRUT P3200 Series, or approved equal.

E. ACCESSORIES:

1. HANGER RODS: Rods shall be carbon steel, threaded on both ends or continuous threaded and sized as specified.

2. WELDLESS EYE NUT: Eye nut shall be forged steel and shall comply with MSS and FEDSPEC Type 17. Eye nut shall be Grinnell Fig. 290, B–Line B3200, or equal.

3. WELDED EYE ROD: Eye rod shall be carbon steel with eye welded closed. Inside diameter of eye shall accommodate a bolt diameter 1/8 inch larger than the rod diameter. Eye rod shall be Grinnell Fig. 278, B–Line B3211, or equal.

4. TURNBUCKLE: Turnbuckle shall be forged steel and shall comply with MSS and FEDSPEC Type 13. Turnbuckle shall be Grinnell Fig. 230, B–Line B3202, or equal.

5. FRAMING CHANNEL: Framing channel shall be 1 5/8 inches square, roll formed, 12–gage carbon steel. Channel shall have a continuous slot along one side with in–turned clamping ridges. Single channel: Unistrut P1000, B–Line B22, or equal. Double channel: Unistrut P1001, B–Line B22A, or equal. Triple channel: Unistrut P1004A, B–Line B22X, or equal.

2.03 THERMAL PIPE HANGER SHIELD

Thermal shields shall be provided at hanger, support and guide locations on pipe requiring insulation. The shield shall consist of an insulation layer encircling the entire circumference of the pipe and a steel jacket encircling the insulation layer. The thermal shield shall be the same thickness as the piping system insulation specified in 40 27 05.09. The standard shield shall be used for hot systems and the vapor barrier shield shall be used for cold systems.

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Stainless steel band clamps shall be used where specified to ensure against slippage between the pipe wall and the thermal shield.

A. STANDARD SHIELD:

1. INSULATION:

a. Hydrous calcium silicate, high density, waterproof
b. Compressive strength: 100 psi average
c. Flexural strength: 75 psi average
d. K factor: 0.38 at 100 degrees F mean
e. Temperature range: 20 degrees F to 500 degrees F

2. STEEL JACKET: Galvanized steel. Gage shall be the manufacturer's standard supplied for the given pipe size.

3. CONNECTION: Shield shall have butt connection to pipe insulation. Steel jacket and insulation shall be flush with end.

B. VAPOR BARRIER SHIELD:

1. INSULATION:

a. Hydrous calcium silicate, high density, waterproof
b. Compressive strength: 100 psi average
c. Flexural strength: 75 psi average
d. K factor: 0.38 at 100 degrees F mean
e. Temperature range: 20 degrees F to 500 degrees F

2. STEEL JACKET: Galvanized steel. Gage shall be the manufacturer's standard supplied for the given pipe size.

3. CONNECTION: Shield shall have butt connection to pipe insulation. Insulation shall extend 1 inch each side of steel jacket for vapor tight connection to pipe insulation vapor barrier.

2.04 PRODUCT DATA

The following information shall be provided in accordance with Section 01300:

1. Hanger and support locations and components shall be indicated on the piping layout drawings required by paragraph 40 27 05–2.04.

2. Design Professional's reports as specified in paragraph 40 05 15–3.05.

PART 3––EXECUTION

3.01 HANGER AND SUPPORT LOCATIONS

The Contractor shall locate hangers and supports as near as possible to concentrated loads such as valves, flanges, etc. Locate hangers, supports and accessories within the maximum

span lengths specified in the project manual to support continuous pipeline runs unaffected by concentrated loads.

At least one hanger or support shall be located within 2 feet from a pipe change in direction.

The Contractor shall locate hangers and supports to ensure that connections to equipment, tanks, etc., are substantially free from loads transmitted by the piping.

Where piping is connected to equipment, a valve, piping assembly, etc., that will require removal for maintenance, the piping shall be supported in such a manner that temporary supports shall not be necessary for this procedure.

Pipe shall not have pockets formed in the span due to sagging of the pipe between supports caused by the weight of the pipe, medium in the pipe, insulation, valves and fittings.

3.02 INSTALLATION

Welded and bolted attachments to the building structural steel shall be in accordance with the requirements of the AISC Manual of Steel Construction. Unless otherwise specified, there shall be no drilling or burning of holes in the building structural steel.
Hanger components shall not be used for purposes other than for which they were designed. They shall not be used for rigging and erection purposes.

The Contractor shall install items to be embedded before concrete is poured. Fasten embedded items securely to prevent movement when concrete is poured.

Embedded anchor bolts shall be used instead of concrete inserts for support installations in areas below water surface or normally subject to submerging.

The Contractor shall install thermal pipe hanger shields on insulated piping at required locations during hanger and support installation. Butt joint connections to pipe insulation shall be made at the time of insulation installation in accordance with the manufacturer's recommendations.

Hanger and support components in contact with plastic pipe shall be free of burrs and sharp edges.

Rollers shall roll freely without binding.

Finished floor beneath Type N structural attachments and framing channel post bases shall be roughed prior to grouting. Grout between base plate and floor shall be free of voids and foreign material.

Baseplates shall be cut and drilled to specified dimensions prior to welding stanchions or other attachments and prior to setting anchor bolts.

Plastic or rubber end caps shall be provided at the exposed ends of all framing channels that are located up to 7 feet above the floor.

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3.03 ADJUSTMENTS

The Contractor shall adjust hangers and supports to obtain required pipe slope and elevation. Shims made of material that is compatible with the piping material may be used. Stanchions shall be adjusted prior to grouting their baseplates.

3.04 ANCHOR BOLTS

Anchor bolts in new concrete shall be cast in place.

3.05 INSPECTION AND CERTIFICATION

The design professional retained by the Contractor under the provisions of paragraphs 40 27 05–1.02 C and 40 05 15–1.02 B shall inspect the pipe hangers, support and restraint systems at not less than bi–weekly intervals during construction and furnish the Construction Manager with monthly reports. The Design Professional shall inspect the completed pipe hanger, support and restraint system before the Owner assumes beneficial occupancy and provide written certification, <u>without any qualification statements</u>, that the installation conforms to the design professional's design <u>and</u> the Contract Document requirements as may be described in other Sections or on the drawings. All reports shall bear the Design Professional's seal and signature in accordance with the laws, rules and regulations of the state.

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SECTION 40 05 15

APPENDIX A

PIPE HANGERS AND SUPPORTS TABLES

TABLE A - SUPPORT SPACING AND ALLOWABLE ROD LOADS						
NOMINAL PIPE SIZE (INCHES)	SUPPORT ROD SIZE AND MAXIMUM LOAD PER ROD - SEE NOTES 1 AND 2		MAXIMUM SUPPORT SPACING (FEET)			
	ROD SIZE (INCHES)	MAX LOAD (POUNDS)	STEEL	COPPER	PLASTIC SEE NOTE 4	CAST IRON SEE NOTE 5
3/8 TO 3/4	3/8	610	5	5	CONTINUOUS	---
1	3/8	610	5	5	5	---
1-1/4	3/8	610	5	5	5	---
1-1/2	3/8	610	5	5	5	---
2	3/8	610	10	5	5	12 FEET FOR PRESSURE PIPE 10 FEET FOR SOIL PIPE
2-1/2	3/8	610	10	10	5	
3	3/8	610	10	20	5	
4	1/2	1130	10	20	5	
6	5/8	1810	15	20	5	
8	3/4	2710	15	20	5	
10	3/4	2710	20	---	5	
12	1	4960	20	---	10	
14	1	4960	20	---	---	
16	1	4960	20	---	---	
18	1	4960	20	---	---	
20	1-1/4	8000	20	---	---	
24	1-1/4	8000	20	---	---	
30	1-1/2	11630	20	---	---	

TABLE A NOTES:

1. DESIGN WEIGHT SHALL BE TWICE THE WEIGHT OF THE PIPE FULL OF WATER PLUS THE WEIGHTS OF VALVES, FITTINGS, INSULATING MATERIALS AND SUSPENDED HANGER COMPONENTS ON THE RUN OF PIPE BEING SUPPORTED.

2. ROD SIZES SHOWN ARE FOR THE SUPPORT OF A SINGLE PIPE. WHEN SUPPORTING MORE THAN ONE PIPE, ROD SHALL BE SIZED USING DESIGN WEIGHTS (SEE NOTE 1) TO DETERMINE THE TOTAL DESIGN LOAD. THE TOTAL DESIGN LOAD SHALL NOT EXCEED THE MAXIMUM LOADS IN THE TABLE ABOVE.

3. PIPE SHALL NOT HAVE POCKETS FORMED IN THE SPAN DUE TO SAGGING OF THE PIPE BETWEEN SUPPORTS CAUSED BY THE WEIGHT OF THE PIPE, MEDIUM IN THE PIPE, INSULATION, VALVES AND FITTINGS.

4. SPAN SHOWN IS FOR SCHEDULE 80 PVC PIPE AT 100°F. SPANS FOR OTHER PLASTICS, OTHER PVC PIPE SCHEDULES AND PIPES AT HIGHER TEMPERATURES SHALL BE SHORT- ENED IN ACCORDANCE WITH THE PIPE MANUFACTURER'S RECOMMENDATIONS. ``CONTINUOUS" MEANS PIPE SHALL BE IN UNISTRUT OR SIMILAR CHANNEL.

5. PROVIDE A MINIMUM OF ONE HANGER PER PIPE LENGTH, WITHIN 4-INCHES OF THE BELL.

6. PIPE HANGER AND SUPPORT SELECTION SHALL BE IN ACCORDANCE WITH TABLE B (M2302) AND SPECIFICATION SECTION 15096.

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TABLE B HANGER AND SUPPORT SELECTIONS

SYSTEM TEMP RANGE DEG F	INSULATION NOTE 1	PIPE ATTACHMENTS									BUILDING STRUCTURAL ATTACHMENTS			
		HORIZONTAL								VERTICAL	STEEL AND/OR MALL. IRON			
		STEEL STRAPS	STEEL BANDS	STEEL CLAMPS	CAST IRON HANGING ROLLS	CAST IRON SUPPORTING ROLLS	STEEL TRAPEZES AND RACKS	THERMAL HANGER SHIELDS	STEEL OR CAST IRON STANCHIONS	STEEL RISER CLAMPS	INSERTS	BEAM CLAMPS	WELDED AND BOLTED ATTACHMENTS	BRACKETS
HOT A-1 120 TO 450	COVERED	13	1, 2	3	4, 5	8	20, 21	SEE SPEC	10	11, 12	A	C, D	F, J, M	B, G, H, K, L
	BARE	6, 7 13	1, 2	3	4, 5	8	20, 21	NONE	10					
HOT A-2 451 TO 750	COVERED	13	1	3	4, 5	8	20, 21	SEE SPEC	10	11, 12	A	C, D	F, J, M	B, G, H, K, L
	BARE	NONE	NONE	3	NONE	NONE	20, 21	NONE	NONE					
HOT A-3 OVER 750	COVERED	13	1	3 (ALLOY)	4, 5	8	20, 21	SEE SPEC	10	11, 12	NONE	C, D	F, J, M	B, G, H, K, L
	BARE	13	NONE	3 (ALLOY)	NONE	NONE	20, 21	NONE	NONE					
AMBIENT B 60 TO 119	COVERED	13	1, 2	3	4, 5	8	20, 21	SEE SPEC	9,10	11, 12	A	C, D	F, J, M	B, G, H, K, L
	BARE	6, 7 13	1, 2	3	4, 5	8	20, 21	NONE	9,10					
COLD C-1 33 TO 59	COVERED	13	1, 2, 3	3	4, 5	8	20, 21	SEE SPEC	10	11, 12	A	C, D	F, J, M	B, G, H, K, L
	BARE	6, 7 13	1, 2, 3	3	4, 5	8	20, 21	NONE	10					
COLD C-2 -2 TO 32	COVERED	13	1, 2, 3	3	4, 5	8	20, 21	SEE SPEC	10	11, 12	A	C, D	F, J, M	B, G, H, K, L
	BARE	NONE	1, 2, 3	3	4, 5	8	20, 21	NONE	10					

TABLE B NOTES:

1. HANGERS ON INSULATED SYSTEMS SHALL INCORPORATE THERMAL HANGER SHIELDS.
2. HANGER AND SUPPORT SPACING SHALL BE IN ACCORDANCE WITH TABLE A (M2301).

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TABLE C
SEISMIC RESTRAINT SPACING

NOM. PIPE SIZE	MAXIMUM SPAN BETWEEN BRACES		BRACE TYPE	MAXIMUM BRACE LENGTH
	LATERAL BRACE (FEET)	LONGITUDINAL BRACE (FEET)		
2	40	80	A1	9'-4"
2-1/2	40	80	A1	9'-4"
3	40	80	A1	9'-4"
4	40	80	A1	9'-4"
6	40	80	A1	9'-4"
8	40	40	A1	9'-4"
10	40	40	A1	9'-4"
12	40	40	A2	10'-0"
14	30	30	A2	10'-0"
16	25	25	A2	10'-0"
18	20	20	A2	10'-0"
20	16	16	A2	10'-0"
24	10	10	A2	10'-0"

(S) - STANDARD WALL

END OF SECTION

INDEX TO

SECTION 40 05 15.10

SEISMIC RESTRAINTS FOR PIPING

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SECTION 40 05 15.10

SEISMIC RESTRAINTS FOR PIPING

PART 1 – GENERAL

1.01 DESCRIPTION

A. SCOPE:

This section specifies seismic restraints for bracing all piping systems specified in Section 40 27 05. This section does not include seismic restraints for fire sprinkler systems.

B. DEFINITIONS:

1. Longitudinal direction—direction parallel to the pipe axis.
2. Lateral direction—direction perpendicular to the pipe axis.

C. OPERATING CONDITIONS:

The seismic restraints specified in this section are provided to resist pipe movements and loads occurring as a result of an earthquake or other seismic event.

All piping systems shall be provided with seismic restraints conforming to governing state and local codes. Seismic restraints shall conform to the guidelines given in the SMACNA Seismic Restraint Manual for the Seismic Hazard Level consistent with the requirements of governing state and local codes. In case of conflict, the governing state or local code shall be followed.

D. RESTRAINT SELECTION:

1. The Contractor shall select, locate and provide seismic restraints for piping in accordance with this section. As set forth in Paragraph 40 27 05–1.01 A, this work shall be the product of a Design Professional retained by the Contractor.

2. The Contractor shall review the piping layout in relation to the surrounding structure and adjacent piping and equipment before selecting the restraint to be used at each point.

3. Seismic restraints may be omitted from the following installations:

   a. Gas piping less than 1–inch inside diameter.
   b. All other piping less than 2 1/2–inch inside diameter.

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4. Piping systems shall not be braced to dissimilar parts of a building or to dissimilar building systems that may respond in a different mode during an earthquake. Examples: wall and a roof; solid concrete wall and a metal deck with lightweight concrete fill.

5. Restraints shall be sized to fit the outside diameter of the pipe, tubing, or, where specified, the outside diameter of insulation.

6. There shall be no contact between a pipe and restraint component of dissimilar metals. The contractor shall prevent contact between dissimilar metals when restraining copper tubing by the use of copper–plated, rubber, plastic or vinyl coated, or stainless steel restraint components.

7. Branch lines shall not be used to brace main lines.

8. Seismic bracing shall not limit the expansion and contraction of the piping system.

1.02 QUALITY ASSURANCE

A. REFERENCES:

This section contains references to the following documents. They are a part of this section as specified and modified. In case of a conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, whether or not the document has been superseded by a version with a later date, discontinued or replaced.

Reference	Title
AISC Manual of Steel Construction	American Institute of Steel Construction Manual of Steel Construction, Allowable Stress Design, 9th Edition
MFMA–2	Metal Framing Standards Publication
MFMA–101	Guidelines for the Use of Metal Framing
MSS SP–58	Pipe Hangers and Supports – Materials, Design and Manufacture
MSS SP–69	Pipe Hangers and Supports – Selection and Application

Reference	Title
MSS–SP–89	Pipe Hangers and Supports – Fabrication and Installation Practices
SMACNA	Seismic Restraint Manual—Guidelines for Mechanical Systems

B. DESIGN:

The seismic restraint system shall be designed by the Design Professional retained under Paragraph 40 27 05–1.01 A. Seismic restraint details shall be designed in conjunction with preparation of pipe system hangers and drawings specified in paragraph 40 27 05–2.04. All drawings and work product for the seismic restraint system shall bear the design professional's registration seal and signature. The requirement, however, shall not be construed as relieving the Contractor of responsibility for this portion of the work.

PART 2 – PRODUCTS

2.01 ACCEPTABLE PRODUCTS

Standard pipe restraints and components shall be manufactured by Carpenter & Patterson, B–Line, Kin–Line, ITT Grinnell, Michigan, Pipe Shields Incorporated, Superstrut, Unistrut, or equal. Pipe restraint materials, design, manufacture, installation, and application shall conform to the requirements of MSS SP–58, MSS–SP–69, MSS–SP–89, MFMA–1, and MFMA–101.

2.02 MATERIALS

A. GENERAL:

Unless otherwise specified, restraints manufactured of iron or steel, including braces, pipe and structural attachments, shall be hot–dip galvanized after fabrication. Nuts, bolts and washers, fittings and accessories, may be mechanically zinc–coated except for those subject to moisture or corrosive atmosphere, which are listed in paragraph 26 05 00–1.05 B; those compounds shall be type 304 stainless steel. Also listed in paragraph 26 05 00–1.05 B are corrosive areas specifically requiring fiberglass materials. In those areas, all pipe supports, anchor and seismic brace components (not just fittings and accessories) shall be made of fiberglass.

2.03 THERMAL PIPE HANGER SHIELD

Thermal shields shall be provided at seismic restraint locations on pipe requiring insulation. Thermal pipe hanger shields shall be as specified in paragraph 40 05 15–2.03. Stainless steel band clamps shall be provided on thermal shields at longitudinal pipe restraint locations.

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2.04 PRODUCT DATA

The following information shall be submitted:

1. Seismic restraint system drawings and calculations as specified in paragraph 40 05 15.10–1.02 B.

2. Seismic restraint locations and legend as specified in paragraph 40 05 15.10–3.01.

3. The Design Professional's reports and certification of final installation as specified in paragraphs 40 27 05–1.01 A and 40 05 15.10–3.03.

PART 3––EXECUTION

3.01 PIPE RESTRAINT LOCATIONS

The first seismic restraint on a piping system shall be located not more than 10 feet from the main riser, entrance to a building or piece of equipment.

Ductile and cast iron pipe shall be braced on each side of a change in direction of 90 degrees or more. Joints in risers shall be braced or stabilized between floors.

No–hub and bell and spigot cast iron soil pipe shall be braced longitudinally every 20 feet and laterally every 10 feet.

Lateral bracing for one pipe section may also act as longitudinal bracing for the pipe section connected perpendicular to it, if the bracing is installed within 24 inches of the elbow or tee of the same size.

Seismic restraint locations and components shall be indicated on the piping layout drawings required by paragraph 40 27 05–2.04. The drawings shall bear a legend giving load information and restraint component selection at each restraint location and shall be sealed and signed by the Design Professional retained by the Contractor for design of the pipe hanger and support system under the provisions of paragraphs 40 27 05–1.02 C and 40 05 15.10–1.02 B.

3.02 INSTALLATION

Rod stiffener assemblies shall be used at seismic restraints for hanger rods over 6 inches in length. A minimum of two rod stiffener clamps shall be used on any rod stiffener assembly.

Lateral and longitudinal bracing shall be installed between 45 degrees above and 45 degrees below horizontal, inclusive, relative to the horizontal centerline of the pipe.

Welded and bolted attachments to the building structural steel shall be in accordance with the requirements of AISC M011. There shall be no drilling or burning of holes in the building structural steel without approval of the Engineer.

Embedded anchor bolts shall be used instead of concrete inserts for seismic brace installations in new concrete areas below water surface or normally subject to submerging.

The Contractor shall install thermal pipe hanger shields on insulated piping at required locations during restraint installation. Butt joint connections to pipe insulation shall be made at the time of insulation installation in accordance with the manufacturer's recommendations.

Restraint components in contact with plastic pipe shall be free of burrs and sharp edges.

Rollers shall roll freely without binding.

Plastic or rubber end caps shall be provided at the exposed ends of all framing channels that are located up to 7 feet above the floor.

3.03 INSPECTION AND CERTIFICATION

The Design Professional retained by the Contractor under the provisions of paragraphs 40 27 05–1.01 A and 40 05 15.10–1.02 B shall inspect the seismic restraint system at not less than bi–weekly intervals during construction and furnish the Engineer with monthly reports. The Design Professional shall inspect the completed seismic control system before the Owner assumes beneficial occupancy and provide written certification in accordance with Section 40 05 15 requirements.

END OF SECTION

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SECTION 40 05 15.15

EXPANSION CONTROL FOR PIPING

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SECTION 40 05 15.15

EXPANSION CONTROL FOR PIPING

PART 1 - GENERAL

1.01 DESCRIPTION

A. SCOPE:

This section specifies expansion control for the piping systems specified in paragraph 40 05 15.15-1.01 C. This section addresses pipe anchorage, pipe guides, and expansion control by either expansion joints or pipe deflection.

B. DEFINITIONS:

Term	Definition
Expansion joint	Any device containing one or more bellows used to absorb dimensional changes.
Main anchor	An attachment between a structure and a pipe which must withstand the full pipeline thrust due to pressure, pipe bending, pipe compression, flow, spring forces, pipe and contents weight and other pipe forces.
Intermediate anchor	An attachment between a structure and a pipe which withstands the same forces as a main anchor except the pressure forces.
Sliding anchor	An attachment between a structure and a pipe which absorbs forces in one direction while permitting motion in another.
Pipe guide	A device fastened to a structure, which permits the pipeline to move freely in only one direction, along the axis of the pipe.
Pipe section	That portion of pipe between two anchors.
Planar pipe guide	A device fastened to a structure, which permits transverse movement or bending of the pipeline in one plane.
Lateral direction	Direction perpendicular to the pipe axis
Longitudinal direction	Direction parallel to the pipe axis

C. OPERATING CONDITIONS:

Expansion control as specified in this section shall be provided to control pipe movements and loads occurring as a result of pipeline temperature changes.

Those piping systems listed in the following table shall be provided with expansion control conforming to good engineering practice.

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Piping system	Minimum temperature, degrees F	Maximum temperature, degrees F
A, AA, BA, CA, IA, SA	17 (exterior –20)	300 (exterior 200)
CS, DS, LSG, MSG (and combinations)	30 (exterior –20)	120
EE	-20	1000
GRR/S	-20	200
HW, HRR/S	70	230
Unlisted Piping (exterior)	-20	120
Unlisted Piping (interior)	30	120

1.02 QUALITY ASSURANCE

A. REFERENCES:

This section contains references to the following documents. They are a part of this section as specified and modified. In case of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, whether or not the document has been superseded by a version with a later date, discontinued or replaced.

Reference	Title
AISC Manual of Steel Construction	American Institute of Steel Construction, Manual of Steel Construction, Allowable Stress Design - 9th Edition
EJMA-93	Standards of the Expansion Joint Manufacturers Association, Inc., Sixth Edition, 1993
EJMA-85	A Practical Guide to Expansion Joints, Copyright 1985, Expansion Joint Manufacturers Association, Inc.

B. DESIGN:

The expansion control system shall be designed by the Contractor's Design Professional selected under paragraph 40 27 05-1.01A. Expansion control details shall be designed in conjunction with preparation of pipe system hangers and

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seismic restraint systems drawings specified in paragraph 40 27 05-2.04. The resulting drawings and work product for the expansion control system shall bear the Design Professional's registration seal and signature. The requirement, however, shall not be construed as relieving the Contractor of responsibility for this portion of the work.

C. DESIGN GUIDELINES:

The Design Professional shall use the following guidelines in preparation of the designs and calculations specified in paragraph 40 05 15.15-1.02 B:

1. The difference between the minimum and maximum temperatures listed in the table in paragraph 40 05 15.15-1.02 C shall be used for calculating pipe expansion.

2. Published coefficients of thermal expansion for pipe materials shall be used for the listed temperature range. The source of the coefficients of expansion used in the calculations shall be included with the information provided as Product Data.

3. Expansion control systems shall be designed for maximum reliability. Unless otherwise indicated on the Drawings, "L", "U", or "Z" bends shall be employed to control expansion in preference over expansion joints.

4. Expansion control systems using pipe bends shall be designed to limit bending stress in the pipe associated with deflection at the worst case temperature difference. The maximum allowable bending stress shall be 1/3 of the yield stress for the pipe material. If loading conditions or uncertainties warrant, a lower allowable stress value shall be used. A recognized pipe bending stress calculation method and documentation supporting its use shall be provided as Product Data.

5. Expansion control design for expansion joints shall conform to the guidelines given in the Standards of The Expansion Joint Manufacturers Association, Inc. (EJMA).

6. If the Design Professional chooses to use expansion control or pipe support methods that involve higher loadings on the structure than are specified and/or shown on the drawings, the Construction Manager shall be notified in the submittal required in paragraph 40 27 05-2.04. The requested loads shall be listed and the Construction Manager will redesign the structure as necessary at the Contractor's expense.

7. The test pressures listed in the PIPESPEC sheets shall be used when calculating pressure forces.

8. Pipe guides or planar pipe guides shall be provided to control the movement of pipes when "L", "U", or "Z" bends are used for expansion control. The guides shall be located as indicated in EJMA standards. An alternative recognized standard may be used for this purpose only upon approval by the Construction Manager.

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9. For piping systems with potentially large loads, recommended main anchor locations are shown on the drawings. Intermediate anchors shall be provided as needed. Maximum forces that the structure can withstand at the main anchor points are noted on the drawings. Anchors shall be designed to attach to the structure and solidly to the pipe. Pipe clamps or U-bolts are not allowed unless they are designed to withstand the forces imposed upon the anchor and have stops welded to the pipe so that the pipe cannot slip in the anchor.

10. Anchors and guides shall be coordinated with the pipe support systems specified in Section 40 05 15 and seismic restraints specified in Section 40 05 15.10.

11. The design of the expansion control, pipe support and seismic restraints for the listed piping systems shall be integrated to provide maximum flexibility for maintenance access to equipment, appurtenances such as valves etc., and to the pipe itself.

12. The piping layout indicated shall be reviewed in relation to, surrounding structures, adjacent piping and equipment before selecting the anchors, guides, and expansion control method to be used at each point.

13. There shall be no metal-to-metal contact between a pipe and restraint component of dissimilar metals.

14. Branch lines shall not be used to anchor main lines.

15. For elevated pipe sections, fabricated support frames or other appropriate structures shall be designed to withstand the specified loads plus gravity and seismic loads. The supports shall be designed to provide access to equipment, walkways, gates, and other piping.

1.03 SUBMITTALS

The following information shall submitted for approval:

1. Expansion control schedules as specified in paragraph 40 05 15.15-3.01.

PART 2 - PRODUCTS

2.01 MATERIALS

Unless otherwise specified, anchors, and guides shall be manufactured of iron or steel, including braces, pipe and structural attachments, and shall be hot-dip galvanized after fabrication. Supports cast integrally with cast iron fittings are specifically prohibited for use in any application where shear forces may be imposed on the support. Structural anchors may be fabricated from structural steel and coated. Nuts, bolts and washers may be zinc-plated except for those subject to moisture or corrosive atmosphere, as specified in paragraphs 26 05 00-1.05 B and C, which shall be Type 304 stainless steel. Also listed in paragraph 26 05 00-1.05 C are corrosive areas specifically requiring fiberglass materials. In those areas, all pipe support, anchor and brace components (not just fittings and accessories) shall be made of fiberglass.

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2.02 PRODUCT DATA

The following product data shall be Submitted for Approval:

1. Anchor bolt calculations.

2. The Design Professional's reports and final certification, as specified under paragraph 40 05 15.15-3.03.

PART 3 - EXECUTION

3.01 EXPANSION CONTROL SCHEDULES

A. GENERAL:

Anchor, guide, and expansion joint locations shall be indicated on the piping layout drawings required by paragraphs 40 27 05-2.04 and 40 05 15.15-1.02 B. In addition, schedules shall be prepared as specified below.

B. ANCHORS:

The anchor schedule shall list as a minimum:

1. Anchor Point Label
2. Pipe Size and Service
3. Contract Drawing No.
4. Layout Drawing No.
5. Forces
6. Load, pounds
7. Direction
8. Anchor Description
9. Remarks

C. GUIDES:

The guide schedule shall list as a minimum:

1. Guide Label
2. Pipe Size and Service
3. Contract Drawing No.
4. Layout Drawing No.
5. Guide Description
6. Remarks

D. EXPANSION JOINTS:

The expansion joint schedule shall list as a minimum:

1. Expansion Joint Label
2. Pipe Size and Service

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3. Contract Drawing No.
4. Layout Drawing No.
5. Movement, inches
   a--Lateral movement
   b--Compression movement
   c--Extension movement
   d--Angular movement
6. Maximum Spring Force, pounds
7. Test Pressure, psig
8. Pressure Force, pounds
9. Total Forces
10. Load, pounds
11. Direction
12. Expansion Joint Description
13. Special Features
14. Remarks

3.02 INSTALLATION

The Contractor shall install the expansion control system in accordance with the drawings required in paragraph 40 05 15.15-1.02 B.

Welded and bolted attachments to the building structural steel shall be in accordance with the requirements of the AISC Manual of Steel Construction. There shall be no drilling or burning of holes in the building structural steel without approval of the Construction Manager.

Unless otherwise specified, embedded anchor bolts shall be used instead of concrete inserts, wedge anchors, expansion anchors, adhesive, or other non-embedded type of anchor for expansion control installations in areas below water surface or normally subject to submerging.

The Contractor shall install thermal pipe hanger shields on insulated piping at required locations during guide installation. Butt joint connections to pipe insulation shall be made at the time of insulation installation in accordance with the manufacturer's recommendations. Anchors shall be directly connected to the pipe by welding or another acceptable, positive means.

Components in contact with plastic pipe shall be free of burrs and sharp edges. Rollers shall roll freely without binding. Plastic or rubber end caps shall be provided at the exposed ends of all framing channels that are located up to 7 feet above the floor.

3.03 INSPECTION AND CERTIFICATION

The Design Professional retained by the Contractor under the provisions of paragraphs 40 27 05-1.01 A and 40 05 15.15-1.02 B shall inspect the completed expansion control system at not less than bi-weekly intervals during construction and furnish the Construction Manager with monthly reports. The Design Professional shall inspect the completed expansion control system before the Owner assumes beneficial occupancy and provide written certification in accordance with Section 40 05 15 requirements.

END OF SECTION

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SECTION 40 27 01.02

STEEL PIPE

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SECTION 40 27 01.02

STEEL PIPE

PART 1 – GENERAL

1.01 DESCRIPTION

This section specifies steel pipe and fittings.

1.02 QUALITY ASSURANCE

A. REFERENCES:

This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced.

Reference	Title
ANSI B16.3	Malleable Iron Threaded Fittings, Class 150 and 300
ANSI B16.9	Factory–Made Wrought Steel Buttwelding Fittings
ANSI B16.11	Forged Steel Fittings, Socket–Welding and Threaded
ASTM A36/A36M	Structural Steel
ASTM A47	Ferritic Malleable Iron Castings
ASTM A53	Pipe, Steel, Black and Hot–Dipped, Zinc–Coated Welded and Seamless
ASTM A105/A105M	Forgings, Carbon Steel, for Piping Components
ASTM A106 REV A	Seamless Carbon Steel Pipe for High–Temperature Service
ASTM A197	Cupola Malleable Iron
ASTM A234/A234M	Pipe Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and Elevated Temperatures

Reference	Title
ASTM A283/A283M REV A	Low and Intermediate Tensile Strength Carbon Steel Plates, Shapes and Bars
ASTM A536	Ductile Iron Castings
ASTM A570/A570M	Hot–Rolled Carbon Steel Sheet and Strip, Structural Quality
ASTM A572/A572M REV B	High Strength Low Alloy Columbium–Vanadium Steels of Structural Quality
AWWA C200	Steel Water Pipe 6 Inches and Larger
AWWA C205	Cement–Mortar Protective Lining and Coating for Steel Water Pipe—4 In. and Larger— Shop Applied
AWWA C206	Field Welding of Steel Water Pipe
AWWA C207	Steel Pipe Flanges for Waterworks Services—Sizes 4 In. Through 144 In.
AWWA C208	Dimensions for Fabricated Steel Water Pipe Fittings
AWWA C209	Cold–Applied Tape Coating for Special Sections, Connections, and Fittings for Steel Water Pipelines
AWWA C210	Liquid Epoxy Coating Systems for the Interior and Exterior of Steel Water Pipe
AWWA C214	Tape Coating Systems for the Exterior of Steel Water Pipelines
AWWA C600	Installation of Ductile–Iron Water Mains and Their Appurtenances
AWWA M11	Steel Pipe—A Guide for Design and Installation
SSPC–SP10	Near–White Blast Cleaning

B. TESTING:

Factory testing shall conform to the requirements of ASTM A53, ASTM A106, or AWWA C200 as applicable.

PART 2 – PRODUCTS

2.01 PIPE MATERIALS

Steel pipe and fittings shall be provided in accordance with ASTM A53, ASTM A106, or AWWA C200 as specified in Section 40 27 05, Piping Systems.

Steel for pipe fabricated to meet requirements of AWWA C200 shall conform to the requirements of ASTM A36, ASTM A572, Grade 42, ASTM A570, Grades 33 and 36, or ASTM A283, Grade D. Steel for ASTM A53 and ASTM A106 pipe shall be Grade B.

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2.02 PIPE MANUFACTURE

Unless otherwise specified, ASTM A53 pipe shall be Type E, electric resistance welded or Type S, seamless pipe as specified in Section 40 27 05. The minimum wall thickness for ASTM A53 or ASTM A106 pipe shall be Schedule 40 for pipe 10 inch diameter and less and 3/8 inch for pipe 12 inch through 24 inch diameter. Increased shell thickness shall be provided where specified.

AWWA C200 pipe shall be straight or spiral seam. The minimum wall thickness shall be 7 gage for pipe 6 inch through 24 inch diameter and 1/4 inch for pipe 26 inch diameter and larger. Increased shell thickness shall be provided where specified.

2.03 CONNECTIONS

Connections shall be as specified in Section 40 27 05 and shall conform to Section 40 27 05.04. Coating for buried connections shall be as specified in paragraph 40 27 05.04–2.06.

2.04 FITTINGS AND APPURTENANCES

Malleable iron threaded fittings and appurtenances shall conform to the requirements of ASTM A47 or ASTM A197, ANSI B16.3.

Unless otherwise specified, steel fittings and appurtenances shall conform to the requirements of ASTM A234, ASTM A105, or ANSI B16.11; and fabricated steel fittings and appurtenances shall conform to AWWA C208.

Fittings for grooved end piping systems shall be full flow cast fittings, steel fittings, or segmentally welded fittings with grooves or shoulders designed to accept grooved end couplings. Cast fittings shall be cast of ductile iron conforming to ASTM A536 or malleable iron conforming to ASTM A47. Standard steel fittings, including large size elbows, shall be forged steel conforming to ASTM A106. Standard segmentally welded fittings shall be fabricated of Schedule 40 carbon steel pipe.

Unless otherwise specified, all fittings shall be rated for pressure and loadings equal to the pipe.

2.05 PIPE LINING

A. EPOXY:

Unless otherwise specified, pipe and fittings shall be lined with a liquid epoxy as specified in AWWA C210 with the following exceptions:

1. No coal tar products shall be incorporated in the liquid epoxy.

2. The curing agent may be an amidoamine as well as the other curing agents listed in AWWA C210.

The lining shall be applied to a minimum thickness of 16 mils in not less than two coats.

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B. CEMENT MORTAR:

Where specified, pipe and fittings shall be lined with cement mortar as specified in AWWA C205. Fittings and specials larger than 24 inches, not fabricated from centrifugally lined straight sections, shall require 2–inch by 4–inch by 13–gage self–furring wire mesh reinforcement for hand–applied lining.

C. HIGH TEMPERATURE SERVICE EPOXY:

Where specified, steel pipe and fittings shall be epoxy lined with not less than 10 mils of epoxy suitable for temperatures of 225 degrees F. Epoxy lining shall be 3M Scotchkote 306, Porter MCR 65 High Solids Epoxy, or equal. Surfaces shall be prepared in accordance with SSPC–SP 10 Near White Blast Cleaning, and the lining applied as recommended by the manufacturer.

D. GLASS LINING:

Where specified, pipe and fittings shall be glass lined with a dual layer coating system of vitreous material to a minimum thickness of 10 mils. Glass lining shall provide continuous coverage as tested by a low voltage holiday detector with only isolated voids permitted due to casting anomalies. Voids, other than isolated pinholes, shall be cause for rejection.

Pipe and fittings shall have all internal welds ground smooth and any voids or slag holes ground out, rewelded and ground smooth.

Glass lining shall be Ferrock MEH–32, Vitco SG–14, or equal.

2.06 PIPE COATING

A. EPOXY:

Unless otherwise specified, pipe and fittings shall be coated with a liquid epoxy as specified in AWWA C210 with the following exceptions:

1. No coal tar products shall be incorporated in the liquid epoxy.

2. The curing agent may be an amidoamine as well as the other curing agents listed in AWWA C210.

   The coating shall be applied to a minimum thickness of 16 mils in not less than two coats.

B. POLYETHYLENE TAPE:

Where specified, pipe and fittings shall be coated and wrapped with prefabricated multilayer cold applied polyethylene tape coating in accordance with AWWA C214. The coating application shall be a continuous step operation in conformance with AWWA C214, Section 3. The total coating thickness shall be not less than 50 mils for pipe 24 inches and smaller and not less than 80 mils for pipe 26 inches and larger.

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2.07 FUSION EPOXY COATING AND LINING

Where specified, steel pipe and fittings shall be fusion epoxy coated and lined. The fusion epoxy coating shall be 3M Scotchkote 203, or equal. Surface preparation shall be in accordance with SSPC–SP 10 Near White Blast Cleaning. The application method shall be by the fluidized bed method and shall attain 12 mils minimum dry film thickness.

Field welds, connections and otherwise damaged areas shall be coated and patched according to the manufacturer's instructions with 3M Scotchkote 306.

2.08 JOINT GASKETS

Joint gaskets shall be as specified in Section 40 27 05.02.

2.09 PRODUCT DATA

The following information shall be submitted for approval:

1. Affidavits of Compliance with AWWA C200, ASTM A53, or ASTM A106 as applicable.

2. Contractor's layout drawings as specified in paragraph 40 27 05–2.04.

PART 3––EXECUTION

3.01 INSTALLATION

A. GENERAL:

Pipe shall be installed in accordance with AWWA M11, Chapter 16. Welded joints shall be in accordance with AWWA C206 and Section 40 27 05.04.

Sleeve–type mechanical pipe couplings shall be provided in accordance with AWWA M11 and paragraph 40 27 05.04–2.02 A.

Pipe lining and coatings at field joints shall be applied as specified in paragraphs 40 27 01.02–2.05 and 2.06.

Unless otherwise specified, buried mechanical couplings and valves shall be field coated as specified in paragraph 40 27 05.04–2.06.

B. ANCHORAGE:

Anchorage shall be provided as specified. Calculations and drawings for proposed alternative anchorage shall be submitted in accordance with Section 01300.

3.02 TESTING

Hydrostatic testing shall be in accordance with Section 4 of AWWA C600 except that test pressures and allowable leakage shall be as listed in Section 40 27 05.

END OF SECTION

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SECTION 40 27 01.03

PLASTIC PIPE

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SECTION 40 27 01.03

PLASTIC PIPE

PART 1 – GENERAL

1.01 DESCRIPTION

A. SCOPE:

This section specifies polyvinylchloride, chlorinated polyvinylchloride, polyethylene, and polypropylene pipe and fittings.

B. PIPE DESIGNATIONS:

For use in the Piping System Specification Sheets (PIPESPEC) in Section 40 27 05 and in this section, the following plastic pipe designations are defined:

Designation	Definition
PVC	Polyvinylchloride
CPVC	Chlorinated polyvinylchloride

1.02 QUALITY ASSURANCE

A. REFERENCES:

This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced.

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Reference	Title
ASTM D1248	Polyethylene Plastics Molding and Extrusion Materials
ASTM D1784	Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds
ASTM D1785	Poly (Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120
ASTM D2241	Poly (Vinyl Chloride) (PVC) Plastic Pipe (SDR–PR)
ASTM D2464	Threaded Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80
ASTM D2466	Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40
ASTM D2467	Socket–Type Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80
ASTM D2564	Solvent Cements for Poly (Vinyl Chloride) (PVC) Plastic Pipe and Fittings
ASTM D2657	Heat–Joining Polyolefin Pipe and Fittings
ASTM D2665	Poly (Vinyl Chloride) (PVC) Plastic Drain, Waste, and Vent Pipe and Fittings
ASTM D3034	Type PSM Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings
ASTM D4101	Propylene Plastic Injection and Extrusion Materials
ASTM F402	Safe Handling of Solvent Cements and Primers Used for Joining Thermoplastic Pipe and Fittings
ASTM F437	Threaded Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80
ASTM F438	Socket–Type Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 40
ASTM F439	Socket–Type Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80
ASTM F441	Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe, Schedules 40 and 80
ASTM F477	Elastomeric Seals (Gaskets) for Joining Plastic Pipe
ASTM F493	Solvent Cements for Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe and Fittings

PART 2 – PRODUCTS

2.01 PVC PIPE

A. PRESSURE PIPE:

PVC material for pipe and fittings shall conform to ASTM D1784, Class 12454–B. Pipe and fittings shall either be in accordance with ASTM D1785 or shall conform to ASTM D2241 for standard dimension ratios: 160 psi pipe—SDR 26; 200 psi pipe—SDR 21;

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250 psi—SDR 17. Pressure rating for pipe shall be in excess of test pressure specified in Section 40 27 05. Neoprene gaskets with push–on joints shall conform to ASTM F477.

Schedule 80 PVC socket type fittings shall conform to ASTM D2467. Schedule 40 PVC fittings shall conform to ASTM D2466. PVC solvent weld cement for socket connections shall meet the requirements of ASTM D2564. Schedule 80 PVC threaded fittings shall conform to ASTM D2464. Fittings for gasketed pipe shall be ductile iron or steel push–on IPS–sized pressure fittings rated for use with the specified class of PVC pipe. Unless otherwise specified, fittings shall be lined and coated in accordance with Section 33 05 01.03 as applicable.

B. NONPRESSURE PIPE:

1. GRAVITY SEWER PIPE: PVC material for sewer pipe and fittings shall conform to Class 12454–B, as defined in ASTM D1784. Pipe and fittings shall meet the requirements of ASTM D3034 for SDR 26. Neoprene gaskets with push–on joints shall conform to ASTM F477.

2. DRAIN, WASTE AND VENT PIPE: PVC material for drain waste and vent (DWV) pipe and fittings shall conform to Class 12454–B, ASTM D1784. Pipe and fittings shall conform to ASTM D2665. Unless otherwise specified, connections shall be solvent weld. Connections to traps, closet flanges, and nonplastic pipe shall be with approved adapter type fittings designed for intended use. Solvent weld cement for socket connections shall meet requirements of ASTM D2564.

2.02 CPVC PIPE

CPVC material for pipe and fittings shall conform to ASTM D1784, Class 23447–B. Pipe and fittings shall be in accordance with ASTM F441. Neoprene gaskets with push–on joints shall conform to ASTM F477.

Schedule 80 CPVC socket type fittings shall conform to ASTM F439. Schedule 40 CPVC socket type fittings shall conform to ASTM F438. CPVC solvent weld cement for socket connections shall meet the requirements of ASTM F493. Schedule 80 CPVC threaded type fittings shall conform to ASTM F437.

2.03 PRODUCT DATA

The following information shall be provided:

1. Manufacturer's certificates of compliance with the specified standards and Contractor's layout drawings.

PART 3 – EXECUTION

3.01 INSTALLATION

PVC pipe 3 inches in diameter and smaller shall be joined by means of socket fittings and solvent welding in conformance with ASTM F402. Solvent–cemented joints shall be made in

strict compliance with the manufacturer's/supplier's instructions and recommended procedures. Unless otherwise specified, PVC pipe 4 inches in diameter and greater shall be joined by means of gasketed push–on joints and steel or ductile iron push–on or mechanical joint fittings. Fittings shall be lined and coated as specified in Section 33 05 01.03. Unless otherwise specified, PVC and CPVC piping exposed to sunlight shall be painted.

Connections to different types of pipe shall be by means of flanges, specified adapters or transition fittings. Where sleeve type couplings are used, both shall be uniformly torqued in accordance with pipe manufacturer's recommendation. Foreign material shall be removed from the pipe interior prior to assembly.

Unless otherwise specified, PE pipe and fittings 4 inch diameter and smaller shall be joined by means of thermal socket fusion and pipe 6 inch and larger by thermal butt fusion. Butt–fusion joining of the pipes and fittings shall be performed with special joining equipment in accordance with procedures recommended by pipe manufacturer. Tensile strength at yield of butt–fusion joints shall not be less than pipe. Flanged adapters shall be provided for connection to valves and where specified.

3.02 TESTING

Testing of plastic piping shall be as specified in Section 40 27 05.

END OF SECTION

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SECTION 40 27 01.04

COPPER PIPING

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SECTION 40 27 01.04

COPPER PIPING

PART 1–GENERAL

1.01 DESCRIPTION

This section specifies copper piping, tubing, couplings and fittings.

1.02 REFERENCES

This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced.

Reference	Title
ANSI B16.22	Wrought Copper and Copper Alloy Solder Joint Pressure Fittings
ANSI B16.26	Cast Copper Alloy Fittings for Flared Copper Tubes
ASTM B32	Solder Metal
ASTM B88	Seamless Copper Water Tube

PART 2 – PRODUCTS

2.01 COPPER TUBING

Copper tubing shall be seamless copper, conforming to ASTM B88. Unless otherwise specified, copper tubing shall be Type L, drawn, where used in exposed service and Type K, annealed or drawn for buried service.

2.02 COUPLINGS AND FITTINGS FOR COPPER TUBING

Unless otherwise specified, couplings and fittings for copper tubing 1/2 inch and smaller nominal diameter shall be compression type, brass or bronze, capable of holding the full bursting strength of the tubing; shall meet the requirements of ANSI B16.26; and shall be Swagelok, Gyrolok, or equal.

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Couplings and fittings for copper tubing larger than 1/2–inch nominal diameter shall be wrought copper or bronze, solder joint pressure fittings and shall conform to ANSI B16.22.

2.03 SOLDER

Solder to be used in copper piping shall be ASTM B32, Alloy Grade Sn95 or Silvabrite 100.

2.04 PRODUCT DATA

Contractor's layout drawings and catalog data demonstrating compliance with this specification and giving full description of the copper piping shall be provided in accordance with contract submittal requirements.

PART 3 – EXECUTION

3.01 FABRICATION

A. SOLDER JOINTS:

All pipe and fittings to be jointed with solder shall be free from all burrs and wire brushed or steel wool cleaned. After cleaning, a paste flux shall be evenly and sparingly applied to the surfaces to be joined. Solder shall then be applied and flame passed toward the center of the fitting until the solder disappears. All excess solder shall be removed while it is still plastic. Absolutely no acid flux or acid wipe shall be used in making solder joints.

B. TAKEDOWN COUPLINGS:

Takedown couplings shall be screw union type and shall be provided in accordance with paragraph 40 27 05.04–3.03.

C. DIELECTRIC PROTECTION:

Copper tubing or fittings shall not be permitted to come in contact with steel piping, reinforcing steel, or other steel at any location. Electrical checks shall be made to assure no contact is made between copper tubing and steel elements. Wherever electrical contact is demonstrated by such tests, the Contractor shall provide dielectric protection in accordance with Section 40 27 05.04– 3.05.

3.02 INSTALLATION, CLEANING, DISINFECTION, AND TESTING

The installation, cleaning, disinfection, and testing of copper piping shall be as specified in Section 40 27 05.

END OF SECTION

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SECTION 40 27 01.05

STAINLESS STEEL PIPING

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SECTION 40 27 01.05

STAINLESS STEEL PIPING

PART 1 – GENERAL

1.01 DESCRIPTION

A. SCOPE:

This section specifies stainless steel pipe and fittings.

B. TYPES OF SERVICE:

Stainless steel piping specified in this section shall be used for Aeration piping.

1.02 QUALITY ASSURANCE

A. REFERENCES:

This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

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Reference	Title
ANSI B16.1	Cast Iron Pipe Flanges and Flanged Fittings Classes 25, 125, 250, and 800
ANSI B16.11.80	Forged Steel Fittings, Socket Welding and Threaded.
ANSI B31.1	Power Piping
ANSI B36.19M	Stainless Steel Pipe
ASME Section IX (1989)	Boiler and Pressure Vessel Code; Welding and Brazing Qualifications

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Reference	Title
ASTM A182/A182M	Forged or Rolled Alloy-Steel Pipe Flanges, Forged Fittings, and Valves and Parts for High-Temperature Service
ASTM A193/A193M	Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service
ASTM A194/A194M	Carbon and Alloy Steel Nuts for Bolts for High Pressure and High-Temperature Service
ASTM A240	Heat-Resisting Chromium and Chromium Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels
ASTM A276	Stainless and Heat-Resisting Steel Bars and Shapes
ASTM A312/A312M	Seamless and Welded Austenitic Stainless Steel Pipes
ASTM A320/A320M	Alloy Steel Bolting Materials for Low-Temperature Service
ASTM A403/A403M	Wrought Austenitic Stainless Steel Piping Fittings
ASTM A409/A409M	Welded Large Diameter Austenitic Steel Pipe for Corrosive or High Temperature Service
ASTM A480/A480M	General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet and Strip
ASTM A774/A774M	As-Welded Wrought Austenitic Stainless Steel Fittings for General Corrosive Service at Low and Moderate Temperatures
ASTM A778	Welded, Unannealed Austenitic Stainless Steel Tubular Products

B. QUALIFICATIONS:

All shop fabricated stainless steel pipe and fittings shall be furnished by a single manufacturer who is experienced and qualified in the manufacture and fabrication of the items to be furnished. The pipe and fittings shall be shop-fabricated and field-installed in accordance with common industry wide practices and methods and shall comply with these specifications.

Only weld procedures which have been qualified under ASME Section IX and only welders who have successfully completed performance qualification tests per ASME Section IX on these qualified procedures shall be utilized.

C. TESTING:

Factory testing shall conform to the requirements of ASTM A312, ASTM A409 HT-0, or ASTM A778, depending on the size and type of stainless steel pipe provided.

1.03 SUBMITTALS

The following information shall be provided in accordance with Section 01300:

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1. A copy of this specification section, with addendum updates included, and all referenced and applicable sections, with addendum updates included, with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements. A check mark shall denote full compliance with a paragraph as a whole. If deviations from the specifications are indicated, and therefore requested by the Contractor, each deviation shall be underlined and denoted by a number in the margin to the right of the identified paragraph, referenced to a detailed written explanation of the reasons for requesting the deviation. The Construction Manager shall be the final authority for determining acceptability of requested deviations. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the specifications. *Failure to include a copy of the marked-up specification sections, along with justification(s) for any requested deviations to the specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration*.

2. Shop fabrication drawings showing details of materials, piping, fittings, couplings, dielectric connections, joint locations and details, types and locations of supports.

3. Other data necessary to show conformance of the complete piping system to these specifications.

PART 2 – PRODUCTS

2.01 PIPE

Unless otherwise specified, stainless steel pipe 2-1/2 inches and smaller shall be Type 304L, seamless, threaded joints conforming to ASTM A312. The minimum wall thickness shall be Schedule 40S.

Unless otherwise specified, stainless steel piping 3 inches and larger shall be manufactured from ASTM A240 annealed and pickled sheets and plates, Type304L, in accordance with ASTM A778 or ASTM A409 HT-0. The minimum wall thickness shall be Schedule 5S. Only extra-low carbon (ELC) materials with 0.030 percent maximum carbon shall be used

2.02 FITTINGS

Unless otherwise specified, stainless steel fittings, 2-1/2-inches and smaller, shall be ASTM A403, of the same material and pressure rating as the pipe, threaded long radius with dimensions conforming to ANSI B16.11.

Unless otherwise specified, stainless steel fittings, 3-inch and larger, shall be butt-weld type manufactured in accordance with ASTM A774 of the same material and in the same thicknesses as the pipe. Reducers shall be straight tapered, cone type. Tees, crosses, laterals, and wyes shall be shop-fabricated from pipe.

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2.03 JOINTS

Stainless steel pipe fabricated into spool pieces shall have shop-welded circumferential butt-weld joints or flanges. Unless otherwise specified, flanged joints shall be Van Stone joints made up of stainless steel slip-on type rolled-angle face rings and ductile iron backup flanges drilled to ANSI B16.1, Class 125 standard. The angle face ring thickness shall be equal to or greater than the wall of the pipe or fitting to which it is welded, and it shall be continuously welded on both sides to the pipe or fitting. The angle leg shall not interfere with the flange bolt holes. For submerged joints, backup flanges shall be stainless steel plate flanges. The backup flanges shall be supplied with the following nominal thicknesses.

Nominal pipe size, inches	Flange thickness, inches
3	1/2
4	9/16
6-10	5/8

2.04 COUPLINGS

A. GENERAL:

Fabricated stainless steel piping shall be shop-prepared for pipe couplings where specified. Unless otherwise specified, couplings shall be arched-band or grooved type.

B. SLEEVE TYPE:

Sleeve type couplings, where specified, shall be of standard steel construction as specified in paragraph 40 27 05.04-2.02 A. Pipe shall be plain-end with external weld beads ground smooth to ensure proper gasket seating. For pressure pipe lines, sleeve coupling joints shall be restrained by the use of harness rods connecting across the joint to flange lugs on adjacent flange joints. Where no adjacent flange joints exist, stainless steel harness lugs shall be welded to the pipe to receive the harness rods.

C. ARCHED-BAND TYPE:

Arched-band type couplings shall be stainless steel of the same material and wall thickness as the pipe and shall be Depend-O-Lok type as manufactured by Brico or equal. Couplings shall be Fixed--FxF, Expansion--ExE, or Fixed by Expansion--FxE as specified or as required. The pipe shall be plain-end with external weld beads ground smooth and with S.S. restraining rings shop-welded to the piping for fixed type couplings.

D. GROOVED-END TYPE:

Grooved-end or split type couplings shall be malleable iron or ductile iron as specified in paragraph 40 27 05.04-2.02 C except that submerged couplings shall be the same material as the pipe. The pipe ends shall be roll-grooved to the coupling manufacturer's specifications. Where roll grooving is impractical, the pipe shall have

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heavy-wall machine-grooved pipe nipples or machined ring collars fully welded to the pipe or fitting. Nipples shall be taper-bored to the I.D. of the adjoining pipe to allow full-weld penetration. Collars shall be welded on both sides to the piping. Nipples and collars shall be of the same alloy as the piping.

E. EXPANSION TYPE:

Unless otherwise specified, expansion couplings shall be the flanged rubber arch type as specified in Section 40 27 05.06. Pipe flanges shall be provided for these couplings.

2.05 THREADED CONNECTIONS

Threaded pipe, gage, or instrument connections shall be made using stainless steel, 150-pound, threaded half-couplings conforming to ASTM A182 or ASTM A276, shop welded to the pipe at the locations specified.

2.06 GASKETS

Unless otherwise specified, gaskets shall be as specified in the PIPESPECS and in paragraph 40 27 05.04-2.03. For air lines, gaskets shall be neoprene or EPDM suitable for use at temperatures to 240 degrees F.

2.07 BOLTS

Bolts, nuts, and washers for stainless steel flange assemblies and stainless steel couplings shall be the same material, conforming to ASTM A320 for low-temperature service and ASTM A193 and ASTM A194 for high-temperature service. Bolts, nuts and washers for other couplings shall be as specified in referenced paragraphs for the couplings.

2.08 PIPE SUPPORT SYSTEMS

Unless otherwise specified, all hangers, rods, structural attachments, and other components of support systems for stainless steel pipe shall be of the same materials as the pipe and conform to Section 40 05 15.

2.09 FINISH

After all shop operations have been completed, pipe and fittings shall be pickled and passivated in manufacturer's plant, and scrubbed and washed until discoloration and possible iron picked up from manufacturing process are removed. The standard finish for 16-gage through 8-gage material shall be No. 1 or 2B per ASTM A480; 3/16-inch and heavier plate material shall be No. 1 mill finish or better per ASTM A480.

2.10 PRODUCT DATA

The following information and data shall be submitted for approval:

1. Certifications specified in the following documents:

   ASTM A403, paragraph 14.1
   ASTM A774, paragraph 14.1

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ASTM A778, paragraph 14.1
ASTM A409, paragraph 17.1

2. Test results specified in paragraph 40 27 01.05-1.02 C.

3. Names and qualification records of proposed welders.

PART 3 – EXECUTION

3.01 PIPE CUTTING, THREADING, AND JOINTING

Pipe cutting, threading, and jointing shall conform to the requirements of ANSI B31.1. All pipe threads shall be lubricated with Teflon tape.

3.02 WELDING

A. GENERAL:

Piping with wall thickness up to 11 gage (0.120 inch) shall be welded with the TIG (GTAW) process. Unless otherwise specified, heavier walls shall be properly beveled and have a root pass with the TIG (GTAW) process followed by subsequent passes with the TIG (GTAW), MIG (GMAW), or Metallic Arc (SMAW) process. Filler wire of ELC grades only shall be added to all welds to provide a cross section at the weld equal to or greater than the parent metal. Weld deposit shall be smooth and evenly distributed and have a crown of no more than 1/16 inch on the I.D. and 3/32 inch on the O.D. of the piping. Concavity, undercut, cracks, or crevices shall not be allowed. Butt welds shall have full penetration to the interior surface, and inert gas shielding shall be provided to the interior and exterior of the joint. Excessive weld deposits, slag, spatter, and projections shall be removed by grinding. Welds on gasket surfaces shall be ground smooth.

B. FIELD WELDING:

Field welding shall be minimized to the greatest extent possible by use of couplings and prefabrication of pipe systems at the factory. Pipe butt welds may be performed at the job site, providing the but welds are performed only with an inert gas shielded process and that other applicable specified welding requirements are rigidly adhered to.

All residue, oxide, and heat stain is to be removed from any type of field weld and the affected areas adjacent by the use of stainless steel wire brushes, followed by cleaning with an agent such as Eutectic Company's "Eucleen," or equal, followed by complete removal of the agent.

C. PREPARATION OF SURFACES TO BE WELDED:

Surfaces of joints to be welded shall be free from mill scale, slag, grease, oil, paint, rust, and other foreign material. Joints to be welded shall be wire-brushed with stainless steel wire brushes and precisely fitted before welding.

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D. WEATHER CONDITIONS:

Welding shall be done only when the surfaces are completely free of any moisture. Welding of the pipe shall not be done during periods of high winds or rain unless the areas being welded are properly shielded.

E. TACK WELDS, CLIPS, AND OTHER ATTACHMENTS:

Nicks, gouges, notches, and depressions in the base metal in the area of the joint shall be repaired before the joint weld is made. Tack welds, clips, and other attachments shall be removed and defects repaired, except where the tack welds occur within the weld area and these tack welds do not exceed the size of the completed weld. Cracked tack welds shall be removed. Areas to be repaired shall be ground to clean metal and then repaired by building up with weld metal. The repaired areas shall be ground smooth to form a plane surface with the base metal.

F. DEFECTS AND REPAIRS:

Welds with cracks, slag inclusions, porosity, undercutting, incomplete penetration, or which are otherwise deficient in quality or made contrary to any provisions of these specifications shall be removed by chipping or grinding throughout their depth to clean base metal. Calking or peening of welds to correct defects shall not be done. Welds found deficient in dimension but not in quality shall be enlarged by additional welding after thoroughly cleaning the surface of previously deposited metal and the adjoining plate. Weld deposits, slag, weld spatter, and projections into the interior of the pipe shall be removed by grinding.

3.03 MARKING, SHIPPING, AND STORAGE

All pipe, fittings, and fabrications shall be properly marked with type, gage, and heat number. All fabricated piping shall have openings plugged and flanges secured for storage and/or transport after fabrication. All fabricated piping shall be piece-marked with identifying numbers or codes which correspond to the Contractor's layout and installation drawings. The marks will be located on the spools at opposite ends and 180 degrees apart. Pipe spools shall be loaded and blocked and lagged as necessary to ensure protection from damage during shipping. Stainless steel pipe and fittings shall be stored per manufacturer's recommendation. Dents, gouges, and scratches in stainless steel pipe and fittings are not acceptable and are reason for rejecting pipe and fittings.

3.04 FABRICATION/INSTALLATION REQUIREMENTS

The piping supplier during manufacturing, fabricating and handling stages, and the Contractor during handling and installation stages, shall use extreme care to avoid the contact of any ferrous materials with the stainless steel piping. All saws, drills, files, wire brushes, etc. shall be used for stainless steel piping only. Pipe storage and fabrication racks shall be nonferrous or stainless steel or rubber-lined. Nylon slings or straps shall be used for handling stainless steel piping. Contact with ferrous items may cause rusting of iron particles embedded in the piping walls. After installation, the Contractor shall wash and rinse all foreign matter from the piping surface. All welded joints shall be treated with a pickling solution, brushed with stainless steel wire brushes and rinsed clean. If rusting of embedded iron occurs, the Contractor shall pickle the affected surface with Oakite Deoxidizer SS, or equal, scrub with stainless steel brushes, and rinse clean.

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3.05 COATINGS

After installation, the Contractor shall paint all steel or iron flanges, couplings, and appurtenances. Painting of the stainless steel pipe is not required. However, the Contractor shall be responsible for supplying and installing the stainless steel piping with a consistently clean surface. Identifying spool piece marks shall be removed with paint thinner or solvents and the entire stainless steel surface shall be washed with detergent and hot water and rinsed clean.

END OF SECTION

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PIPING SYSTEMS

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SECTION 40 27 05

PIPING SYSTEMS

PART 1 – GENERAL

1.01 DESCRIPTION

A. Scope:

1. General – This section specifies systems of process piping and general requirements for piping systems. Detailed specifications for the components listed on the Piping System Specification Sheets are found in other sections of Division 40 and 33. This section shall be used in conjunction with those sections.

   The majority of the valves are provided on this project by Ovivo as part of their equipment package. The valves listed in this specification are for valves that are not part of their package. The contractor shall coordinate with Ovivo to confirm the pipe connections to the valves supplied in their package.

   Contractor shall provide all piping and ancillary devices as shown, specified and required to provide a fully functional system.

2. Contractor Design of Piping Systems – In addition to materials, labor, and plant required to construct piping systems, Contractor shall provide professional engineering services (“Design Professional”) for the design and inspection of piping systems work.

   The Contractor shall provide the final design, inspection, and certification for the piping supports, seismic restraints, and provisions for control of dynamic forces and pipe expansion for buried and exposed piping on this project. Pipe supports are specified under Section 40 05 15. Seismic restraints are specified under Section 40 05 15.10. Pipe expansion control systems are specified under Section 40 05 15.15. The design of these systems shall be the product of a professional engineer currently licensed to practice in the State of South Carolina retained by the Contractor. The professional engineer (hereinafter and in all referenced sections the "Design Professional") shall obtain and maintain professional liability insurance in the amount of $1,000,000 aggregate to be in effect for duration of this project plus one year. The Design Professional shall have not less than five years experience in the type of piping support, seismic restraint and expansion control design work required for this project. This requirement, however, shall not be construed as relieving the Contractor of overall responsibility for this portion of the work. Documentation demonstrating qualifications and insurance shall be submitted.

B. Definitions:

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Pressure terms used in Section 40 27 05 and elsewhere in Division 40 are defined as follows:

1. Maximum: The greatest continuous pressure at which the piping system operates.

2. Test: The hydrostatic pressure used to determine system acceptance.

1.02 QUALITY ASSURANCE

A. References – This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced.

Reference	Title
ANSI A13.1	Scheme for the Identification of Piping Systems
ANSI B1.20.1	Pipe Threads, General Purpose (Inch)
ANSI B16.1	Cast Iron Pipe Flanges and Flanged Fittings Class 25, 125, 250, and 800
ANSI B16.3	Malleable Iron Threaded Fittings Class 150 and 300
ANSI B16.5	Pipe Flanges and Flanged Fittings
ANSI B16.9	Factory–Made Wrought Steel Buttwelding Fittings
ANSI B16.11	Forged Steel Fittings, Socket Welding and Threaded
ANSI B16.12	Cast Iron Threaded Drainage Fittings
ANSI B31.3	Chemical Plant and Petroleum Refinery Piping
ASME Section IX	Boiler and Pressure Vessel Code; Welding and Brazing Qualifications
ASTM A53	Pipe, Steel, Black and Hot Dipped, Zinc–Coated Welded and Seamless

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Reference	Title
ASTM A105/A105M	Forgings, Carbon Steel, for Piping Components
ASTM A106	Seamless Carbon Steel Pipe for High–Temperature Service
ASTM A126	Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings
ASTM A197	Cupola Malleable Iron
ASTM A234/A234M	Pipe Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and Elevated Temperatures
ASTM A536	Ductile Iron Castings
ASTM C564	Rubber Gaskets for Cast Iron Soil Pipe and Fittings
ASTM D1248	Polyethylene Plastics Molding and Extrusion Materials
ASTM D1784	Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds
ASTM D1785	Poly (Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120
ASTM D2241	Poly (Vinyl Chloride) (PVC) Plastic Pipe (SDR–PR)
ASTM D2665	Poly (Vinyl Chloride) (PVC) Plastic Drain, Waste, and Vent Pipe and Fittings
ASTM D3034	Standard Specification for Type PSM Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings
AWWA C105	Polyethylene Encasement for Ductile–Iron Piping for Water and Other Liquids
AWWA C110	Ductile–Iron and Gray–Iron Fittings, 3 Inch Through 48 Inch, for Water and Other Liquids
AWWA C111	Rubber–Gasket Joints for Ductile–Iron and Gray–Iron Pressure Pipe and Fittings
AWWA C115	Flanged Ductile–Iron and Gray–Iron Pipe with Threaded Flanges
AWWA C151	Ductile–Iron Pipe, Centrifugally Cast in Metal Molds or Sand–Lined Molds, for Water or Other Liquids
AWWA C200	Steel Water Pipe 6 Inches and Larger
AWWA C205	Cement–Mortar Protective Lining and Coating for Steel Water Pipe—4 In. and Larger—Shop Applied
AWWA C206	Field Welding of Steel Water Pipe

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Reference	Title
AWWA C207	Steel Pipe Flanges for Waterworks Services—Sizes 4 In. through 144 In.
AWWA C208	Dimensions for Fabricated Steel Water Pipe Fittings
AWWA C209	Cold–Applied Tape Coating for Special Sections, Connections, and Fittings for Steel Water Pipelines
AWWA C210	Liquid Epoxy Coating Systems for the Interior and Exterior of Steel Water Pipe
AWWA C214	Tape Coating Systems for the Exterior of Steel Water Pipelines
AWWA C600	Installation of Ductile–Iron Water Mains and Their Appurtenances
AWWA C651	Disinfecting Water Mains
AWWA C900	Polyvinyl Chloride (PVC) Pressure Pipe, 4 Inches Through 12 Inches, for Water
AWWA M11	Steel Pipe—A Guide for Design and Installation
FEDSPEC L–C–530B(1)	Coating, Pipe, Thermoplastic Resin or Thermosetting Epoxy
MIL–H–13528B	Hydrochloric Acid, Inhibited, Rust Removing
MIL–STD–810C	Environmental Test Methods
UPC	Uniform Plumbing Code

B. Fittings and Coupling Compatibility – To assure uniformity and compatibility of piping components, fittings and couplings for grooved–end or shouldered–end piping systems shall be furnished by the same manufacturers.

C. Piping Supports, Seismic Restraints, and Expansion Control – Piping supports, seismic restraints, anchorage, and expansion control shall be designed by the Contractor's Design Professional selected under paragraph 40 27 05–1.01A. There may be situations where the Owner wants to control where certain anchors are located, the level of forces that can be transmitted to structures, the direction that expansion growth is allowed, or requires use of particular piping elements. In such cases these elements will be shown and shall be incorporated into the Design Professional's design.

Mandatory anchorage locations will be identified on the mechanical drawings, and maximum limitations, if any, for structure loads from the anchor will listed in kips, e.g. "X, 50", identifying location and 50,000 lb–force. Where structural load would be exceeded, piping flexibility or expansion joints shall be provided to achieve the maximum loading. If a particular type of support, anchor, seismic restraint or expansion element is detailed on the drawings, then those elements shall be incorporated into the Contractor's design. Piping submittals by the Contractor shall

include all elements, including those portions directed by the Owner, as well as complete piping runs. The structural reaction loads for all fixed supports shall be calculated and shown. The Contractor's Design Professional shall, as part of the submittal process, notify the Owner if he believes any Owner–shown elements are incompatible with the overall piping system and its function.

Additional requirements are specified in related sections.

D. Buried Piping – All buried piping shall be designed as fully–restrained systems. Where required, Design Professional shall size temporary and/or permanent thrust restraints. Restraint systems shall be designated to allow complete piping system disassembly without destructive measures.

Buried piping shall be provided as specified. Unless otherwise noted, materials specified in the PIPESPEC shall be used. Thicknesses specified in the PIPESPEC or referenced specifications shall be considered minimums. Excavation, installation and backfill shall be as specified.

Piping submittals by the Contractor shall include all elements, including those portions directed by the Owner, as well as complete piping runs. If a particular type of restraint or expansion element or approach is detailed on the drawings, then those elements shall be incorporated into the Contractor's design. The Contractor's Design Professional shall, as part of the submittal process, notify the Owner if he believes any Owner–shown elements are incompatible with the overall piping system and its function.

Additional requirements are specified in related sections.

1.03 SUBMITTALS

The following material shall be submitted for approval:

1. The qualifications of the Design Professional to be charged with design, inspection and certification of pipe supports, thrust and seismic restraints and pipe expansion control systems including education, proof of registration, proof of insurance, and previous experience in performing this type of work. The documentation shall be sufficient to demonstrate compliance with the requirements of paragraph 40 27 05–1.01 A. ***No further submittals under this or any related section will be considered until the qualifications of the Design Professional have been reviewed and accepted by the Construction Manager of Engineer of Record.***

2. A copy of this specification section, along with Sections 40 05 15, 40 05 15.10 and 40 05 15.15, with addendum updates included, and all referenced and applicable sections, with addendum updates included, with each paragraph check–marked to indicate specification compliance or marked to indicate requested deviations from specification requirements. Check marks shall denote full compliance with a paragraph as a whole. If deviations from the specifications are indicated and, therefore requested by the Contractor, each deviation shall be underlined and denoted by a number in the margin to the right of the identified paragraph, referenced to a detailed written explanation of the reasons for requesting the

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deviation. The Construction Manager and Engineer of Record shall be the final authority for determining acceptability of requested deviations. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the specifications. **Failure to include a copy of the marked–up specification sections, along with justification(s) for any requested deviations to the specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.**

PART 2 – PRODUCTS

2.01 PIPING MATERIALS

Unless otherwise specified, piping materials, including pipe, gaskets, fittings, connection and joint assemblies, linings and coatings, shall be selected from those listed on the piping system specification sheets. Piping materials shall conform to detailed specifications for each type of pipe and piping appurtenance specified in other sections of Division 40.

New and existing piping is designated by service rather than pipe material. Existing pipe material types may not be the same as material types specified for new piping. Contractor shall investigate and provide suitable connections, including electrical isolation, as necessary.

2.02 PIPING IDENTIFICATION

A. Plastic Coding Markers – Plastic markers for coding pipe shall conform to ANSI A13.1 and shall be as manufactured by W. H. Brady Company, Seton Name Plate Corporation, Marking Services Inc., or equal. Markers shall be the mechanically attached types that are easily removable; they shall not be the adhesive applied type. Markers shall consist of pressure sensitive legends applied to plastic backing which is strapped or otherwise mechanically attached to the pipe. Legend and backing shall be resistant to petroleum based oils and grease and shall meet criteria for humidity, solar radiation, rain, salt, fog and leakage fungus, as specified by MIL–STD–810C. Markers shall withstand a continuous operating temperature range of –40 degrees F to 180 degrees F. Plastic coding markers shall not be the individual letter type but shall be manufactured and applied in one continuous length of plastic.

Markers bearing the legends on the background colors specified in the PIPESPEC shall be provided in the following letter heights:

Outside Pipe Diameter,[a] Inches	Letter height, inches
Less than 1–1/2	1/2
1–1/2 through 3	1–1/8
Greater than 3	2–1/4

[a] Outside pipe diameter shall include insulation and jacketing.

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In addition, pipe markers shall include uni– and bi–directional arrows, indicating flow direction, in the same sizes as the legend. Legends and arrows shall be white on blue or red backgrounds and black on other specified backgrounds.

B. Plastic Tracer Tape – Tracer tape shall be 6 inches wide, colored the same as the background colors as specified in Table A, paragraph 40 27 05–3.07, and made of inert plastic material suitable for direct burial. Tape shall be capable of stretching to twice its original length and shall be as manufactured by Allen Systems, W. H. Brady Co., Seton Name Plate Corporation, Marking Services Inc., or equal.

Two messages shall be printed on the tape. The first message shall read ***"CAUTION CAUTION CAUTION _____ PIPE BURIED BELOW"*** with bold letters approximately two inches high. The blank shall be filled with the particular system fluid such as chlorine, oxygen or sulfur dioxide. The second message shall read *"**CALL**_____"* with letters approximately 3/4 inch high. Both messages shall be printed at maximum intervals of 2 feet.

C. Magnetic Tracer Tape – Polyethylene magnetic tracer tape shall be as manufactured by Allen Systems, W.H. Brady Co., Seton Name Plate Corporation, Marking Services Inc., or equal. Tape shall be acid and alkali–resistant, three inches wide, 0.005-inch thick, and have 1,500 psi strength and 140% elongation value. The tape shall be colored the same as the background colors as specified in paragraph 40 27 05–3.07 and shall be inscribed with the words "**CAUTION—PIPE BURIED BELOW**" and the name of the piping system.

2.03 VALVES

Valves of the same size and service shall be provided by a single valve manufacturer. Packing shall be non–asbestos material. Actual length of valves shall be within 1/16 inch (plus or minus) of the manufacturer's specified length. Flanges shall meet the requirement of ANSI B16.5. Push–on and mechanical joints shall meet the requirements of AWWA C111. Valve operators are specified in Section 40 29 01.

2.04 PRODUCT DATA

Product data on piping materials and layout shall be submitted for approval:

A. Pre–Construction Data – All information specified shall be transmitted to the Engineer a minimum of four weeks prior to construction.

1. Design drawings and calculations for pipe supports, anchorage, seismic restraints, and expansion control systems as specified in Sections 40 05 15, 40 05 15.10, and 40 05 15.15. The drawings and calculations shall be sealed and submitted by the design professional specified in paragraph 40 27 05–1.02C through the Contractor. The Design Professional shall affirm that loads on structures are within the load limits noted on the contract documents.

2. Manufacturers' product literature on each bend, coupling, fitting, bolt, gasket, restraint or other item provided pursuant to this section.

3. A schedule showing the quantity provided and the piping system for each

item provided under this section.

4. Piping layout drawings, for both exposed and buried piping systems, depicting supports, locations of support, fittings and restraints, seismic restraint provisions, and other pertinent information, including wall and floor penetrations, where applicable. Submitted piping layout drawings shall clarify detailed connections to new and existing equipment, piping and structures. Unless otherwise indicated on drawings, piping fitting angles and vertical and horizontal pipe locations shall be determined by Contractor and depicted on piping layout drawings. Drawings shall be original layouts by the Contractor; photocopies of contract drawings are not acceptable.

   Layout drawings and other Product Data shall be defined and depicted by system.

B. Post–Construction Data: - Inspection reports, authored, sealed and signed by the Design Professional retained under the provisions of paragraph 40 27 05–1.02 A. shall be submitted to the Construction Manager each week, as provided under paragraph 40 27 05–3.04. The Design Professional's final report shall be submitted to the Construction Manager and Engineer of Record before beneficial occupancy by the Owner, as provided under paragraph 40 27 05–3.04.

2.05 PIPE AND VALVE COMPATIBILITY

Selected pipe and pipe end connections for valves, or other equipment, shall be fully compatible within each piping system. Contractor shall coordinate the selection of pipe materials, linings and end connections so that valves operate properly over their entire range (e.g. sufficient disk clearance for butterfly valves). Selected end connections shall also be suitable for specified valve or equipment (e.g. wafer style valves or spectacle flanges shall be properly supported between flanges of equal inside diameter).

PART 3 – EXECUTION

3.01 INSTALLATION

A. Location – The Contract drawings are, in part, diagrammatic. Piping shall be provided as specified except for adjustments to avoid architectural and structural features and shall be coordinated with electrical construction. Adjustments to new piping shall be made to avoid interference and shown on the pipe layout drawings.

   Submitted piping layout drawings shall clarify detailed connections to new and existing equipment, piping and structures. Unless otherwise indicated on drawings, piping fitting angles and vertical and horizontal pipe locations shall be determined by Contractor.

B. Piping Sizes – Where the size of piping is not specified, the Contractor shall provide piping of the sizes required by UPC. Unless specified otherwise, small piping (less than one inch in diameter) required for services not described by UPC shall be 1/2 inch.

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C. Existing Piping Materials – Contractor shall pothole existing pipe at connections to new pipe to confirm material and joints prior to commencement of work.

D. Pipe Support, Anchorage, and Seismic Bracing:

1. General – Piping shall be supported by anchor brackets, guides, saddles or hangers. Pipe movement due to thermal expansion and internal pressure and dynamic forces shall be accommodated by pipe springing, anchors, expansion joints, and guides selected for the specific purpose by the design professional retained under the provisions of paragraph 40 27 05–1.01 A. The details for the piping support, anchorage, seismic bracing, and expansion control systems shall be submitted with the Contractor's piping layout drawings as product data under the provisions of paragraph 40 27 05–2.04.

   Acceptable types of supports, guides, saddles, expansion joints, flexible couplings, hangers and structure attachments for general piping support, expansion/contraction and for seismic bracing, as well as anchorage details, are referenced in Sections 40 05 15, 40 05 15.10 and 40 05 15.15 or shown on the drawings. Where a specific type of support or anchorage is indicated on the drawings, then only that type shall be used at that location.

   Piping shall be vertically supported by anchor brackets, guides, saddles or hangers and shall be seismically braced as required to resist seismic loads. Supports shall be provided on each run at each change of direction. Piping supports manufactured of iron or steel shall be hot–dip or mechanically galvanized.

   Unless otherwise specified, existing pipes and supports shall not be used to support new piping. Existing tunnel pipe support racks can be used for new pipe if the Design Professional determines that the existing rack components are adequate to support the additional load.

2. Piping Connections to Machines – Piping at machine connections shall be aligned in all planes to permit insertion of bolts at bolted connections or coupling screwed connections without using jacks, come–a–longs or other mechanical means to align field piping with the connections at the machines. Bolts shall not be forced into mating flange bolt holes and shall be capable being withdrawn using finger pressure alone. The use of ‘dutchmen’ mitered sections or similar specials to achieve the required alignment with machine connections is strictly prohibited.

E. Anchorage for Buried Piping – All plugs, caps, tees and bends in buried pressure piping systems shall be anchored by means of reaction backing or restrained joints as specified.

F. Bedding and Backfill – Bedding and backfill for buried piping shall be as specified and as shown on the drawings.

G. Equipment Connection Fittings - Equipment connection fittings, as specified in Section 40 27 05.04, shall be provided between field piping systems and equipment inlet and outlet connections.

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H. Buried Pipe at Structures – Unless otherwise specified, buried piping shall have two flexible fittings or couplings where pipe passes through structures per Section 40 27 05.04 and as shown on the drawings. Restraints across each joint shall be provided.

3.02 PIPING IDENTIFICATION

A. Pipe Coding – After application of the specified coating and insulation systems, exposed piping, interior and exterior, and piping in ceiling spaces, pipe trenches, pipe chases and valve boxes shall be identified with plastic markers as specified in paragraph 40 27 05–2.02 A. Legend markers and directional arrows shall be located at each side of walls, floors, and ceilings, at one side of each piece of equipment, at piping intersections, and at approximately 50-foot centers.

B. Plastic Tracer Tape – A single line of tape as specified in paragraph 40 27 05–2.02 B shall be provided 2.5 feet above the centerline of buried systems 4, 5, and 7 pipe. For systems 4, 5, and 7, pipelines buried eight feet or greater below finished grade, Contractor shall provide a second line of tape 12 inches below finished grade, above and parallel to each buried pipe. Tape shall be spread flat with message side up before backfilling.

C. Magnetic Tracer Tape – Polyethylene magnetic tracer tape shall be buried 12 to 18 inches below ground and shall be above and parallel to buried nonferrous, plastic and reinforced thermosetting resin pipe lines. For pipelines buried eight feet or greater below final grade, the Contractor shall provide a second line of tape 2.5 feet above and parallel to the buried pipe.

3.03 VALVE IDENTIFICATION

Stainless steel tags bearing the specified valve number stamped in 1/4–inch high letters shall be installed on valve flanges in a position visible from floor level. Flangeless valves eight inches in diameter and larger shall have tags attached to the valve body by self–tapping corrosion resistant metal screws. Flangeless valves six inches in diameter and smaller shall have tags attached to the valve stem by stainless steel wire. Wire shall be 0.063 inch minimum.

3.04 INSPECTION

The Contractor shall cause the Design Professional retained under the provisions of paragraph 40 27 05–1.01 A to inspect the interior installation of the piping supports, anchorage, seismic restraints, and expansion control systems provided under this contract.

Upon completion of construction, but prior to beneficial occupancy of the piping systems by the Owner, the Design Professional shall conduct a detailed final inspection and furnish the Construction Manager with a final report in accordance with Section 40 05 15 requirements.

3.05 TESTING

A. General – Upon completion of piping, but prior to application of insulation on exposed piping, the Contractor shall test the piping systems. Pressures, media and

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test durations shall be as specified in the PIPESPEC. Equipment which may be damaged by the specified test conditions shall be isolated. Testing shall be performed using calibrated test gages and calibrated volumetric measuring equipment to determine leakage rates. Each test gage shall be selected so that the specified test pressure falls within the upper half of the gage's range. Unless otherwise specified, the Contractor shall notify the Construction Manager 24 hours prior to each test.

Unless otherwise specified, testing, as specified herein, shall include existing piping systems which connect with new pipe systems. Existing pipe shall be tested to the nearest existing valve. Any piping which fails the test shall be repaired. Repair of existing piping will be considered and paid for as extra work.

B. Gas, Air, and Vapor Systems: The Contractor shall test steam lines hydrostatically in accordance with the ASME procedure for testing pressure piping.

Testing medium and procedures for chlorine and sulfur dioxide systems are specified in paragraph 40 27 05–3.05 D.

Unless otherwise specified, the testing medium for other gas, air and vapor systems shall be as follows:

Pipeline Size	Specified Test Pressure	Testing Medium
2 inch and smaller	75 psi or less	Air or water
2 inch and smaller	Greater than 75 psi	Water
Greater than 2 inch	3 psi or less	Air or water
Greater than 2 inch	Greater than 3 psi	Water

The allowable leakage rate for hazardous gas systems, insulated systems, and systems tested with water shall be zero at the specified test pressure throughout the specified test period. Hazardous gas systems shall include sulfur dioxide, chlorine, propane, sludge gas, and natural gas systems.

The allowable leakage rate for other systems tested with air shall be based on a maximum pressure drop of five percent of the specified test pressure for the duration of the period. Prior to starting a test interval using air, the air shall be at ambient temperature and specified test pressure.

C. Liquid Systems – Leakage shall be zero at the specified test pressure throughout the specified duration for the following systems: exposed piping, buried insulated piping, and buried or exposed piping carrying liquid chemicals. Testing procedures for chlorine and sulfur dioxide systems are specified in paragraph 40 27 05–3.05 D. Testing procedures for hydraulic and lube oil systems are specified in paragraph 40 27 05–3.05 E. Unless otherwise specified, leakage from other buried liquid piping systems shall be less than 0.02 gallon per hour per inch diameter per 100 feet of buried piping.

D. Hydraulic and Fluid Power Oil Systems – Upon completion of all field piping, but before connection to any control components, hydraulic and fluid power oil systems shall be flushed and cleaned by circulating special flushing oil through the

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system. Flushing oil and procedures shall comply with ASTM D4174. System shall be cleaned such that internal contamination of system, when tested using procedures specified in SAE J1227, Section 2.3, shall not exceed the Allowable Cleanliness Level (ACL). Unless otherwise specified, the ACL value shall be established by the manufacturer of the major hydraulic system components in accordance with SAE J1227, Section 9.1. System supplier shall provide Certificate of Compliance as product data (paragraph 40 27 05–2.04) that the ACL has been met.

E. Drains – Drain systems, other than pumped drain systems, shall be tested in accordance with UPC.

3.06 CLEANING AND FLUSHING

A. General – Piping systems shall be cleaned following completion of testing and prior to connection to operating, control, and regulating or instrumentation equipment. The Contractor may, at his option, clean and test sections of buried or exposed piping systems. Use of this procedure, however, will not waive the requirement for a full pressure test of the completed system. Unless specified otherwise, piping 24 inches in diameter and smaller shall first be cleaned by pulling a tightly fitting cleaning ball or swab through the system. Piping larger than 24 inches in diameter may be cleaned manually or with a cleaning ball or swab.

B. Temporary Screens – Upon completion of the cleaning, the Contractor shall connect the piping systems to related process equipment. Temporary screens, provided with locator tabs which remain visible from the outside when the screens are in place, shall be inserted in pipelines at the suction of pumps and compressors in accordance with the following table:

Equipment suction or piping size, inches	Maximum screen opening, inches
0 –1	1/16
1-1/4 – 3	1/4
3-1/2 – 6	1/2
Over 6	1

The Contractor shall maintain the screens during testing, initial start–up, and initial operating phases of the commissioning process. In special cases, screens may be removed as required for performance tests. The Contractor shall remove the temporary screens and make the final piping connections after the screens have remained clean for at least 24 consecutive hours of operation. Liquid systems handling solids shall have screens in place for clear water testing and operation. Initial operation on solids following clear water testing may be without screens.

C. Gas and Air Systems – Unless otherwise specified, gas and air system piping six inches in diameter and smaller shall be blown out, using air or the testing medium specified. Piping larger than six inches shall be cleaned by having a swab or "pig" drawn through the separate reaches of pipe. After connection to the equipment, it shall then be blown out using the equipment. Upon completion of cleaning, the piping shall be drained and dried with an airstream. Sludge gas, natural gas and propane systems shall be purged with nitrogen and a nitrogen pad maintained at 10 psi until

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put in service. Chlorine and sulfur dioxide systems shall be cleaned in accordance with paragraph 40 27 05–3.06 E.

D. Liquid Systems – After completion of cleaning, liquid systems, unless otherwise specified, shall be flushed with clean water. With temporary screens in place, the liquid shall be circulated through the piping system using connected equipment for a minimum period of 15 minutes and until no debris is collected on the screens. Liquid chlorine and sulfur dioxide lines shall be cleaned in accordance with paragraph 40 27 05–3.06 E.

Upon completion of all field piping, but before connection to any control components, hydraulic and fluid power oil systems shall be flushed and cleaned by circulating special flushing oil through the system. Flushing oil and procedures shall comply with ASTM D4174. System shall be cleaned such that internal contamination of system, when tested using procedures specified in SAE J1227, Section 2.3, shall not exceed the Allowable Cleanliness Level (ACL). Unless otherwise specified, the ACL value shall be established by the manufacturer of the major hydraulic system components in accordance with SAE J1227, Section 9.1. System supplier shall provide Certificate of Compliance as product data (paragraph 40 27 05–2.04) that the ACL has been met.

E. Potable Water Systems – Potable water piping systems shall be flushed and disinfected in accordance with AWWA C651.

3.07 PIPING SPECIFICATION SHEETS (PIPESPEC)

Piping and valves for groupings of similar plant processes or types of service lines are specified on individual piping specification sheets (PIPESPECS). Piping services are grouped according to the chemical and physical properties of the fluid conveyed and/or by the temperature or pressure requirements. Each grouping of services (PIPESPEC) is identified by a piping system number. Piping services specified in the PIPESPECS and on the drawings are alphabetically arranged by designated service symbols as shown in Table A. Table A also indicates the piping material system number, fluid category, and pipe marker background color of each service.

Table A: Process Piping Services

Pipe Designation	Pipe Service	Material	Interior Lining	Test Pressure, Psi
2W	Nonpotable City Water	ST	–	200
3W	Service Water (Filtered Effluent)	ST	–	200
CA	Compressed Air	SS	–	20
DR / TD	Drain	DI	CL	125
DSF	Diesel Fuel	ST	–	150
FE	Final Effluent	DI	CL	125
NaOH	Sodium Hydroxide	PVC	–	150
PA	Process Air	SS	–	20
PRMT (inside)	Permeate	PVC	–	125
RAS	Return Activated Sludge	ST /DI	EP	125
RS	Raw Sewage	ST /DI	EP	125
SHC	Sodium Hypochlorite	PVC*	–	150
SL	Sludge	DI	EP	100

WAS	Waste Activated Sludge	ST /DI	EP	125

PIPING SPECIFICATION SHEETS —PIPESPEC

Piping Symbol/Service CA—Compressed Air
PA – Process Air

Test Requirements:

Medium: Air; ref. spec paragraph 40 27 05–3.04 B.
Pressure: 20 psig
Duration: 120 minutes

Gasket Requirements:

Flange: Compressed gasketing consisting of organic fibers (Kevlar) and neoprene binder
Mech Cpl: EPDM

Exposed Pipe and Valves:
(See drawings for pipe size and valve type)

(2" and smaller)

Pipe: Stainless steel; ASTM A312, Schedule 40S. Ref. spec Section 40 27 01.05.
Conn; threaded, ANSI B1.20.1.
Ftgs; ASTM A403, material, ends and wall thickness to match pipe.

Valves: Ball; Jamesbury Fig. 351, Nibco T–580, or equal.
Globe; Crane 7TF or 17TF, Lunkenheimer 123 or 214, or equal.
Lift check; Crane 27TFE, Lunkenheimer 231, or equal.

(3" and larger)

Pipe: Stainless steel; ASTM A778. Ref. spec Section 40 27 01.05.
Conn; butt weld or flanged, couplings where specified.
Ftgs; ASTM A774, material, ends and wall thickness to match pipe.

Valves: Butterfly; ref. spec. Section 40 29 13. Line with 10 mils of epoxy per spec Section 40 27 01.02.

Remarks:

PIPING SPECIFICATION SHEETS –PIPESPEC

Piping Symbol/Service: FE—Final Effluent

Test Requirements:

Medium: Water; ref. spec paragraph 40 27 05–3.04 C.
Pressure: 125 psig
Duration: 60 minutes

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Gasket Requirements:

Flange: Compressed gasketing consisting of organic fibers (Kevlar) and neoprene binder

Push–on/Mech Cpl: Nitrile or Neoprene

Exposed Pipe and Valves:

(See drawings for pipe size and valve type)

(3" and smaller)

Pipe: Steel; ASTM A53, galvanized. Ref. spec Section 40 27 01.02.
Conn; taper threaded, ANSI B1.20.1. Flanged adapters for 2–1/2 inch, 3 inch valves.
Ftgs; malleable iron, ASTM A197, ANSI B16.3, Class 150, galvanized.

(2" and smaller)

Valves: Ball; Jamesbury Fig. 351, Nibco T–580, or equal.
Globe; Crane 7TF or 17TF, Lunkenheimer 123 or 214, or equal.
Swing check; Crane 137, Lunkenheimer 230, or equal.

(4" thru 8")

Pipe: Steel; ASTM A53, ERW, Grade B, black, with cement mortar lining. Ref. spec Section 40 27 01.02.
Conn; grooved mech pipe coupling or flanged.
Ftgs; malleable iron, ductile iron, or steel, per spec Section 40 27 01.02; ends and lining to match pipe.

Or

Ductile iron; AWWA C151. Ref. spec Section 33 05 01.03.
Conn; Flanged.
Ftgs; ductile iron, per spec Section 33 05 01.03; coating, lining and ends to match pipe.

(2 1/2" thru 8")

Valves: Butterfly; Ref. spec Section 40 29 13. Substitute Type B on 2–1/2–inch lines.
Swing check; spring loaded per spec Section 40 29 27.

(10" thru 24")

Pipe: Steel; same as 8 inch or AWWA C200, 3/16 inch thick, with cement mortar lining. Ref. spec Section 40 27 01.02.
Conn; same as 8 inch. See Remarks.
Ftgs; steel, ASTM A234, or fabricated steel, AWWA C208. Lining and ends to match pipe.

Valves: Butterfly; ref. spec Section 40 29 13.
Check; per spec Section 40 29 27.

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Buried and Encased Pipe and Valves:
(See drawings for pipe size and valve type. Omit coating on encased pipe.)

(3" and smaller)

Pipe: PVC; ASTM D1784, Class 12454–B, NSF certified, ASTM D1785, Sch. 80. Ref. spec Section 15064. Provide magnetic tracer tape.
Conn; plain end; solvent weld with threaded or flanged adapters for valves.
Ftgs; PVC, Sch. 80, socket weld.

Valves: Butterfly; Ref. spec Section 40 29 13. Substitute Type B on 2–1/2–inch lines.

(4" to 12")

Pipe: Ductile iron; AWWA C151 with cement mortar lining. Ref. spec Section 33 05 01.03.
Conn; grooved end or restrained push–on rubber gasket joint. Flanged adapters for valves.
Ftgs; ductile iron per spec Section 33 05 01.03; coating, lining and ends to match pipe.

Valves: Butterfly; same as exposed with extension stem and valve box. Coating.

PIPING SPECIFICATION SHEETS —PIPESPEC

Piping Symbol/Service: 2W—No. 2 Water (nonpotable City Water)
3W—No. 3 Water (Filtered / Chlorinated Effluent)

Test Requirements:

Medium: Water; ref. spec paragraph 40 27 05–3.04 C.
Pressure: 200 psig
Duration: 120 minutes

Gasket Requirements:

Flange: Compressed gasketing consisting of organic fibers (Kevlar) and neoprene binder
Push–on/Mech Cpl: Nitrile or Neoprene

Exposed Pipe and Valves:
(See drawings for pipe size and valve type)

(2" and smaller)

Pipe: Steel; ASTM A53, galvanized. Ref. spec Section 40 27 01.02.
Conn; taper threaded, ANSI B1.20.1.
Ftgs; malleable iron, ASTM A197, ANSI B16.3, Class 150, galvanized.

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Valves: Ball; Jamesbury Fig. 351, Nibco T–580, or equal.
Globe; Crane 7TF or 17TF, Lunkenheimer 123 or 214, or equal.
Swing check; Crane 137, Lunkenheimer 230, or equal.

(2 1/2" thru 8")

Pipe: Steel; ASTM A53, ERW, Grade B, black, no lining. Ref. spec Section 40 27 01.02.
Conn; butt weld, grooved mech pipe coupling or flanged.
Ftgs; malleable iron, ductile iron, or steel per spec Section 40 27 01.02; ends to match pipe.

Valves: Butterfly; Ref. spec Section 40 29 13. Substitute Type B on 2–1/2–inch lines.
Check; per spec Section 40 29 27.

Buried and Encased Pipe and Valves:
(See drawings for pipe size and valve type. Omit coating on encased pipe.)

(3" and smaller)

Pipe: PVC; ASTM D1784, Class 12454–B, ASTM D1785, Sch. 80. Ref. spec Section 15064. Provide magnetic tracer tape.
Conn; plain end; solvent weld with threaded or flanged adapters for valves.
Ftgs; PVC, Sch. 80, socket weld.

Valves: Gate; ref. spec Section 15101, with extension stem and valve box. Coating.

(4" thru 12")

Pipe: Ductile iron; AWWA C151. Ref. spec Section 33 05 01.03.
Conn; grooved end or restrained push–on rubber gasket joint. Flanged adapters for valves.
Ftgs; ductile iron per spec Section 33 05 01.03; coating, lining and ends to match pipe.

Valves: Butterfly; same as exposed with extension stem and valve box. Coating.

Remarks:

1. Manual air vents shall be provided at the high points and drains provided at the low points of each reach of pipeline as specified in paragraph 40 27 05.08–3.03.

PIPING SPECIFICATION SHEETS –PIPESPEC

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Piping Symbol/Service: TD–Tank Drain

Test Requirements:

Medium: Water; ref. spec paragraph 40 27 05–3.04 C.
Pressure: 125 psig
Duration: 120 minutes

Gasket Requirements:

Flange: Compressed gasketing consisting of organic fibers (Kevlar) and neoprene binder
Push–on/Mech Cpl: Nitrile or Neoprene

Exposed Pipe and Valves:
(See drawings for pipe size and valve type)

(2 1/2" thru 4")

Pipe: Steel; ASTM A53 ERW, Grade B, black, no lining. Ref. spec Section 40 27 01.02.
Conn; butt weld, grooved mech pipe coupling or flanged.
Ftgs; malleable iron, ductile iron, or steel per spec Section 40 27 01.02; ends to match pipe.

Valves: Mud Valves; per spec Section 40 29 50.

(6" thru 12")

Pipe: Ductile iron; AWWA C151. Ref. spec Section 33 05 01.03.
Conn; Flanged.
Ftgs; ductile iron, per spec Section 33 05 01.03; coating, lining and ends to match pipe.

Valves: Mud Valves; per spec Section 40 29 50.

Buried and Encased Pipe:
(See drawings for pipe size. Omit coating on encased pipe.)

(3" and smaller)

Pipe: PVC; ASTM D1784, Class 12454–B, ASTM D1785, Sch. 80. Ref. spec Section 15064. Provide magnetic tracer tape.
Conn; plain end; solvent weld with threaded or flanged adapters for valves.
Ftgs; PVC, Sch. 80, socket weld.

(4" thru 12")

Pipe: Ductile iron; AWWA C151. Ref. spec Section 33 05 01.03.
Conn; Flanged.
Ftgs; ductile iron, per spec Section 33 05 01.03; coating, lining and ends to match pipe.

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PIPING SPECIFICATION SHEETS —PIPESPEC

Piping Symbol/Service: RAS—Return Activated Sludge
WAS—Waste Activated Sludge
RS– Raw SewageTest Requirements:
Medium: Water; ref. spec paragraph 40 27 05–3.04 C.
Pressure: 125 psig
Duration: 120 minutes

Gasket Requirements:
Flange: Compressed gasketing consisting of organic fibers (Kevlar) and neoprene binder
Push–on/Mech Cpl: Nitrile or Neoprene

Exposed Pipe and Valves:
(See drawings for pipe size and valve type)

(3" and smaller)
Pipe: Steel; ASTM A53, galvanized. .
Conn; taper threaded, ANSI B1.20.1.
Ftgs; malleable iron, ASTM A197, ANSIB16.3, Class 150, galvanized.

Valves: Eccentric plug; per spec Section 40 29 19. Install valve with seat upstream.
Swing check; Lunkenheimer 230, Crane 137, or equal.

(4" thru 12")
Pipe: Ductile iron; AWWA C151. Epoxy Lined Ref. spec Section 33 05 01.03.
Conn; flanged.
Ftgs; ductile iron, per spec Section 33 05 01.03; ends to match pipe.

Valves: Eccentric plug; per spec Section 40 29 19. Install valve with seat upstream.
Check; per spec Section 40 29 27.

PIPING SPECIFICATION SHEETS —PIPESPEC

Piping Symbol/Service: SL—Sludge

Test Requirements:
Medium: Water; ref. spec paragraph 40 27 05–3.04 C.
Pressure: 100 psig
Duration: 120 minutes

Gasket Requirements:
Flange: Compressed gasketing consisting of organic fibers (Kevlar) and neoprene binder

Push–on/Mech Cpl: Nitrile or Neoprene

Exposed Pipe and Valves:
(See drawings for pipe size and valve type)

(4" thru 12")

Pipe: Ductile iron; AWWA C151. Ref. spec Section 33 05 01.03.
Conn; flanged or mechanical.
Ftgs; ductile iron, per spec Section 33 05 01.03; ends to match pipe.

Valves: Eccentric plug; per spec Section 40 29 019. Install valve with seat upstream.

PIPING SPECIFICATION SHEETS —PIPESPEC

Piping Symbol/Service: DSF—Diesel Fuel

Test Requirements:

Medium: Fuel oil; ref. spec paragraph 40 27 05–3.04 E.
Pressure: 150 psig (pressure piping)
5 psig (nonpressure piping)
Duration: 60 minutes

Gasket Requirements:

Flange: Compressed gasketing consisting of organic fibers (Kevlar) and neoprene binder
Push–On/Mech Cpl: N/A

Exposed Pipe and Valves:
(See drawings for pipe size and valve type)

(2" and smaller)

Pipe: Steel; ASTM A106, seamless, Grade B, black, pickled. Ref. spec Section 40 27 01.02.
Conn; threaded or socket weld with threaded adapters for valves.
Ftgs; forged steel, ASTM A105, ANSI B16.11, pressure Class 3000, pickled.

Valves: Lubricated plug; cast iron, PTFE coated plug, Nordstrom Fig. 142, Walworth Fig. 1796, or equal.
Lift check; Crane 27TF, Lunkenheimer 231, or equal.

(2 1/2" thru 12")

Pipe: Steel; ASTM A53, seamless, Grade B, black, pickled. Ref. spec Section 40 27 01.02.
Conn; butt weld, flanged for valves.
Ftgs; steel, ASTM A234, seamless, ANSI B16.9, pickled; ends shall match pipe.

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Valves: Lubricated plug; cast iron with PTFE or molydisulfide coated plug, Nordstrom Fig. 143, Walworth Fig. 1797F, or equal, thru 5 inch; worm gear operator Rockwell Fig. 149, Walworth Fig. 1727F, or equal, 6 to 12 inches.

Swing check; cast iron, flanged, Jenkins 1025–B2, Walworth 5344F, or equal.

Buried and Encased Pipe and Valves:
(See drawings for pipe size and valve type.)

(2" and larger)

Pipe: Reinforced thermosetting resin (RTRP); Type 1, ref. spec Section 15058. Double containment unless otherwise specified. Provide magnetic tracer tape.
Conn; bonded bell and spigot or flanged.
Ftgs; RTRP to match pipe, ref. spec Section 15058.

Valves: Lubricated plug; same as exposed with extension stem and valve box.

Remarks:

1. The cleaning (pickling) solution used shall comply with Mil–H–13528B. Immediately following pickling and rinsing procedures, steel pipe and fittings shall be coated inside and outside with a rust and corrosion preventative system, and the ends sealed to prevent the entry of dirt.

PIPING SPECIFICATION SHEETS –PIPESPEC

Piping Symbol/Service: PRMT – Permeate
NaOH–Caustic Soda
SHC—Sodium Hypochlorite (See Remark 1)

Test Requirements:

Medium: Water; ref. spec paragraph 40 27 05–3.04 C.
Pressure: 150 psig
Duration: 120 minutes

Gasket Requirements:

Flange: PTFE bonded EPDM, full–face gaskets, ANSI B16.1.
Push–on/Mech Cpl: N/A

Exposed Pipe and Valves:
(See drawings for pipe size and valve type)

(All sizes)

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Pipe: PVC; ASTM D1784, Class 12454–B, ASTM D1785, Sch. 80. Pipe and fittings exposed to sunlight shall be painted. Ref. spec Section 15064.
Conn; plain end, solvent weld, flanged for valves 3 inch and larger.
Ftgs; PVC, Sch. 80, solvent weld.

(4" and less)

Valves: Ball; PVC Chemtrol Tru Bloc TU Series, Asahi/America Duo Bloc TU Series, GSR TU Series, or equal, with PTFE seats and EPDM 0–rings.
Diaphragm; PVC body, Chemtrol Series PD, Posacon 677, Asahi/America, or equal with EPDM or PTFE diaphragm.
Ball check; PVC body, Chemtrol Series BC, Asahi/America, or equal with EPDM or PTFE seats/seals.

(5" and larger)

Valves: Diaphragm; ITT Dia–Flo 2558–2–M, Hills–McCanna 0649–1–38, or equal.
Swing or ball check; fully lined valve body; fully coated swing check flapper or ball check ball; lining and coating shall be Hypalon or fluorinated ethylene propylene. Valve and Primer Co. APCO Series 100R, Peabody Dore Model 770, or equal.

Buried and Encased Pipe and Valves:
(See drawings for pipe size and valve type)

(All sizes)

Pipe: PVC; same as exposed. Provide magnetic tracer tape.
Conn; same as exposed.
Ftgs; same as exposed.

(2" and less)

Valves: Ball; same as exposed with extension stem and valve box.

(2 1/2" and larger)

Valves: Diaphragm; same as exposed with extension stem and valve box.

Remarks:

1. For HOCL service, the following shall apply:

a. Ball valves are not permitted on HOCL service.

b. Diaphragm valves 4 inches and smaller shall be provided with PTFE diaphragms; valves 5 inches and

larger shall be provided with Hypalon or PDVF linings with PTFE diaphragms.

c. Sodium hypochlorite solvent weld shall be with adhesives developed specifically for NaOCL service.

2. Manual air vents shall be provided at the high points and drains provided at the low points of each reach of pipeline as specified in paragraph 40 27 05.08–3.03.

END OF SECTION

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JOINT GASKETS

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SECTION 40 27 05.02

JOINT GASKETS

PART 1 – GENERAL

1.01 DESCRIPTION

This section specifies rubber gaskets for push-on compression type joints used with fabricated steel pipe, steel pipe, reinforced concrete pipe, concrete cylinder pipe, and cement mortar lined and coated steel pipe.

1.02 QUALITY ASSURANCE

A. References – This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced.

Reference	Title
ASTM D395	Rubber Property--Compression Set, Test for
ASTM D412	Rubber Properties in Tension, Test for
ASTM D471	Rubber Property--Effect of Liquids, Test for
ASTM D573	Rubber--Deterioration in an Air Oven, Test for
ASTM D1149	Rubber Deterioration--Surface Ozone Cracking in a Chamber (Flat Specimens), Test for
ASTM D2240	Rubber Property--Durometer Hardness, Test for

B. Testing - Certified copies of test reports indicating that the gasket material has been tested and that the results of the tests comply with the requirements specified in paragraph 40 27 05.02-2.02 shall be provided as product data.

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PART 2 – PRODUCTS

2.01 MATERIALS

Gasket stock shall be a synthetic rubber compound in which the elastomer is neoprene. The compound shall contain no less than 50% by volume neoprene and shall be free from factice, reclaimed rubber and other deleterious substances.

2.02 PHYSICAL REQUIREMENTS

The compound shall meet the following physical requirements when tested in accordance with the specified ASTM standards.

A. Tensile (ASTM D412) – The tensile strength shall be 1,500 psi minimum and the ultimate elongation shall be 350 percent minimum.

B. Hardness (ASTM D2240, Type A Durometer) – The compound shall have a hardness in the range of 35 to 50 for concrete spigots and 50 to 65 for steel spigots.

C. Compression Set (ASTM D395) – The compression set shall not exceed 20% when compressed for 22 hours at 70 degrees C.

The test specimens shall be circular discs cut from the gaskets. Test specimens shall be 0.500 (± 0.005 - 0.025) inches in height. The diameter of the test specimen shall be that of the gasket but not to exceed 1.129 ± 0.010 inches in diameter.

D. Aging (ASTM D573) – The test specimen deterioration shall be less than 20 percent reduction in tensile strength, 40 percent reduction in ultimate elongation, and 15 points increase in hardness.

E. Effect of Liquids (ASTM D471): The maximum volume change in oil and in water shall be as follows:
1. Oil: 100% in ASTM oil No. 3.
2. Water: 15%.

The test specimens shall have a thickness of 0.080 ±0.005 inches and shall be circular discs cut from the gasket.

F. Ozone Cracking (ASTM D1149) – The test specimen shall be a gasket loop mounted to give at least 20% elongation. There shall be no cracking visible at two times magnification of the gasket after 100 hours exposure to 1 mg/l ozone at 40 ºC.

2.03 PRODUCT DATA

Provide certified copies of test reports specified in paragraph 40 27 05.02-1.02 B.

PART 3 – EXECUTION

The gaskets shall be installed in accordance with the manufacturer's recommendations.

END OF SECTION

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SECTION 40 27 05.04

PIPING CONNECTIONS

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SECTION 40 27 05.04

PIPING CONNECTIONS

PART 1 - GENERAL

1.01 DESCRIPTION

This section specifies the following methods of connecting metallic piping: flanges, threading, mechanical couplings, equipment connection fittings, dielectric unions, and welding.

1.02 REFERENCES

This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced.

Reference	Title
ASME Bl.1	Unified Inch Screw Threads (UN and UNR Thread Form)
ANSI Bl.20.1	Pipe Threads, General Purpose (Inch)
ANSI B16.1	Cast Iron Pipe Flanges and Flanged Fittings
ANSI B16.5	Pipe Flanges and Flanged Fittings
ANSI B18.2.1	Square and Hex Bolts and Screws Inch Series
ANSI B18.2.2	Square and Hex Nuts (Inch Series)
ANSI B31.1	Power Piping
ANSI B31.3	Chemical Plant and Petroleum Refinery Piping
ASME Section IX	Boiler and Pressure Vessel Code; Welding and Brazing Procedures, Welders, Brazers, and Welding and Brazing Operators Qualifications
ASTM B98	Copper-Silicon Alloy Rod, Bar and Shapes
ASTM F37	Standard Test Methods for Sealability of Gasket Materials
ASTM F104	Standard Classification System for Nonmetallic Gasket Materials

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Reference	Title
ASTM F152	Standard Test Methods for Tension Testing of Nonmetallic Gasket Materials
ASTM F593	Stainless Steel Bolts, Hex Cap Screws, and Studs
AWWA C111	Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings
AWWA C206	Field Welding of Steel Water Pipe
AWWA C207	Steel Pipe Flanges for Waterworks Service-Size 4 in. through 144 in.
AWWA C219	Bolted, Sleeve-Type Couplings for Plain-End Pipe
AWWA C550	Protective Epoxy Coatings for Valves and Hydrants
AWWA C606	Grooved and Shouldered Joints
AWWA M11	Steel Pipe-A Guide for Design and Installation
NSF 61	Drinking Water System Components - Health Effects

1.03 SUBMITTALS

Provide catalog data demonstrating compliance with this specification and giving full description of the piping connections shall be provided in accordance with contract submittal requirements.

PART 2 – PRODUCTS

2.01 FLANGE ASSEMBLIES

A. Flanges:

1. General – Flanges shall either be flat flanges or convoluted ring flanges as specified in the following paragraphs.

2. Flat Flanges – Cast iron flanges shall be faced in accordance with ANSI B16.1. Where companion flanges are used, the flanges on pipe shall be refaced to be flush with the companion flange face. Class 150 and Class 300 forged steel flanges shall be raised face conforming to ANSI B16.5. Lightweight slip-on flanges shall be plain face conforming to AWWA C207, Class B and ANSI B16.5. Unless otherwise specified, steel flanges shall be ANSI B16.5, Class 150 or AWWA C207, Class D. Class E AWWA flanges shall be provided where test pressure exceeds 175 psi. Plain faced flanges shall not be bolted to raised face flanges.

3. Convoluted Ring Flanges – Convoluted ring flanges shall be ductile iron, forged steel or cast stainless steel, designed to bear on hubs welded to the pipe and shall be as manufactured by Improved Piping Products. The Construction Manager knows of no equal. The flange joints shall be rated for not less than 150% of the test pressures listed in Section 40 27 05 and shall conform to the requirements of ANSI B 16.5 and AWWA C207. The flange manufacturer shall be prepared to demonstrate, by certified pressure test that the flanges will meet these requirements.

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B. Gaskets:

1. Gasket material shall be as specified in paragraph 40 27 05.04-2.03.

2. Gaskets for plain faced flanges shall be the full face type. Thickness shall be 1/16 inch for pipe 10 inches and less in diameter, and 1/8 inch for pipe 12 inches and larger in diameter. Unless otherwise specified, gaskets for raised face flanges shall match the raised face and shall be 1/16 inch thick for pipe 3-1/2 inches and less in diameter and 1/8 inch thick for pipe 4 inches and larger.

C. Bolts:

1. Flange assembly bolts shall be ANSI B18.2.1 standard square or hexagon head bolts with ANSI B18.2.2 standard hexagon nuts. Threads shall be ANSI Bl.1, standard coarse thread series; bolts shall be Class 2A, nuts shall be Class 2B. Bolt length shall conform to ANSI B16.5.

2. Unless otherwise specified, bolts shall be carbon steel machined bolts with hot pressed hexagon nuts. Bolts for submerged service shall be made of Type 316 stainless steel in conformance with ASTM F593, marking F593F. Nuts for submerged service shall be made of copper-silicon alloy bronze conforming to ASTM B98, alloy C65100, designation H04 or alloy C65500, designation H04. Bolts and nuts for buried service shall be made of noncorrosive high-strength, low-alloy steel having the characteristics specified in ANSI/AWWA C111/A21, regardless of any other protective coating. Where washers are required, they shall be of the same material as the associated bolts.

2.02 MECHANICAL COUPLINGS

A. Sleeve-Type Couplings:

1. Unless otherwise specified, sleeve-type mechanical pipe couplings shall be Smith-Blair Type 411, Dresser Style 38, or equal, with the stop removed from the middle ring. Reducing couplings shall be Smith-Blair Type 415, Dresser Style 62, or equal. Sleeve-type flanged coupling adapters shall be Smith-Blair Type 913, Dresser Style 128, or equal. Insulating couplings shall be Smith-Blair Type 416, Dresser Style 39, or equal.

2. Bolts for submerged service shall be made of Type 316 stainless steel in conformance with ASTM F593, markingF593F. Nuts for submerged service shall be made of copper-silicon alloy bronze conforming to ASTM B98, alloy C65100, designation H04, or alloy C65500, designation H04. Bolts and nuts for buried service shall be made of noncorrosive high-strength, low-alloy steel having the characteristics specified in ANSI/AWWA C111/A21, regardless of any other protective coating. Where washers are required, they shall be of the same material as the associated bolts.

3. Gaskets shall be as specified in paragraph 40 27 05.04-2.03 and AWWA C111.

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B. Plain End Couplings:

1. Plain end pipe couplings for pipe sizes 6 inches and smaller shall be Gustin-Bacon 200, Victaulic Style 99, or equal for Schedule 80 pipe and Gustin-Bacon 205, Victaulic Style 90, or equal for lighter weight pipe. Plain end couplings for pipe sizes 8 inches and larger shall be Gustin-Bacon 200, Victaulic Style 99, or equal. Unless otherwise specified, bolts and nuts shall comply with AWWA C606.

2. Gaskets shall be as specified in paragraph 40 27 05.04-2.03 and AWWA C606.

C. Grooved End Couplings:

1. Grooved end flexible-type couplings shall be Gustin-Bacon 100, Victaulic Style 77, or equal. Grooved end rigid-type couplings shall be Gustin-Bacon 120 Rigi-Grip, Victaulic Style 07 Zero-Flex, or equal. Flexible-type couplings shall be used for all piping greater than 12 inches in diameter; for pipe 12 inches in diameter and less in rack-mounted tunnel piping applications; and for grooved joints adjacent to pump or blower suction and discharge where grooved couplings are used for noise and vibration control. All other applications for piping 12 inches in diameter and less shall utilize rigid-type couplings. Grooved end flanged coupling adapters shall be either Gustin-Bacon 154, Victaulic Style 741, or equal. Snap-joint grooved end couplings shall be Gustin-Bacon 115, Victaulic Style 78, or equal. Cut grooves are not permitted on fabricated or lightwall pipe.

2. Unless otherwise specified, bolts and nuts shall comply with AWWA C606. Bolts for submerged service shall be Type 316 stainless steel in conformance with ASTM F593, marking F593F. Nuts for submerged service shall be made of copper-silicon alloy bronze conforming to ASTM B98, alloy C65100, designation H04 or alloy C65500, designation H04. Bolts and nuts for buried service shall be made of noncorrosive high-strength, low-alloy steel having the characteristics specified in ANSI/AWWA C111/A21, regardless of any other protective coating. Where washers are required, they shall be of the same material as the associated bolts.

3. Gaskets shall be as specified in paragraph 40 27 05.04-2.03 and AWWA C 606.

D. Dismantling Joints – Dismantling joints may be used as takedown couplings in accordance with paragraph 40 27 05.04-3.03. Dismantling joints shall fully restrained double flange fittings consisting of a flange coupling adapter and flanged spool piece that allows for longitudinal adjustment. Thrust restraint shall be provided by means of all threaded rod spanning between flanges and secured to the flanges with a minimum of two flange bolts. Design of equipment connection fittings shall conform to AWWA C219. Sleeves shall be carbon steel or as specified for the specific piping system. Pressure rating of flange adapters shall equal or exceed the pressure rating of mating flanges. All metal portions of equipment connection fittings, with the exception of 316 stainless steel components, shall be coated and lined with fusion bonded epoxy conforming to AWWA C550 and NSF

61. Dismantling joints shall be Romac DJ-400, Smith Blair 975, or Crane-Viking Johnson Dismantling Joint.

E. Sleeve Band Couplings – Sleeve band couplings shall be Victaulic Depend-O-Lock. Unless otherwise noted, couplings for liquid service shall be Model F x F Type 2 fully restrained, shouldered high deflection couplings with standard width band. Couplings shall comply with AWWA C-219. Couplings for use with air systems shall be Airmaster restrained Depend-O-Lock couplings in conformance with AWWA C-606. Sleeve band couplings are acceptable wherever sleeve type couplings are used (paragraph 40 27 05.04-2.02 A.)

2.03 GASKETS

Gaskets designated in Section 40 27 05 shall be as follows:

A. EPDM: ethylene-propylene-diene-terpolymer.

B. Neoprene: neoprene.

C. Nitrile: nitrile (Buna N).

D. Compressed gasketing consisting of organic fibers (Kevlar) and neoprene binder; ASTM F104 (F712400), 2500 psi (ASTM F152), 0.2 ML/HR LEAKAGE FUEL A (ASTM F37).

E. Compressed gasketing consisting of organic fibers (Kevlar) and SBR binder; ASTM F104 (F712400), 2500 PSI (ASTM F152), 0.1 ml/hr leakage Fuel A (ASTM F37).

F. Gylon gasketing, Garlock Style 3500, 2000 psi (ASTM F152), 0.22 ml/hr Fuel A (ASTM F37).

G. Gylon gasketing, Garlock Style 3510, 2000 psi (ASTM F152), 0.04 ml/hr Fuel A (ASTM F37).

H. Gylon gasketing, Garlock Style 3504, 2000 psi (ASTM F152), 0.12 ml/hr Fuel A (ASTM F37).

I. TFE: noncreeping tetrafluoroethylene (TFE) with insert filler.

J. PTFE bonded EPDM: PTFE bonded to EPDM in full-face gasket having concentric-convex molded rings; Garlock Stress Saver 370 or equal.

2.04 THREAD

Pipe thread dimensions and size limits shall conform to ANSI Bl.20.1.

2.05 DIELECTRIC UNIONS

Dielectric unions shall be EPCO, Capitol Manufacturing, or equal.

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2.06 COATINGS

Unless otherwise specified, flange assemblies and mechanical type couplings for buried installation shall be field coated.

2.07 PRODUCT DATA

The Contractor shall provide for each welder, a welder qualification certificate indicating the welder is certified for pipe welding in accordance with ASME Boiler and Pressure Vessel, Section IX. Each welder's certificate shall be provided to the Construction Manager prior to that welder working on the job.

PART 3 – EXECUTION

3.01 PIPE CUTTING, THREADING, AND JOINTING

Pipe cutting, threading, and jointing shall conform to the requirements of ANSI B31.1.

3.02 PIPE WELDING

A. Pipe shall be welded by ASME-certified welders using shielded metal arc, gas shielded arc or submerged arc welding methods. Welds shall be made in accordance with the requirements of ANSI B31.1 for piping Systems 8, 26, and 28 specified in Section 40 27 05. Welds shall be made in accordance with the requirements of ANSI B31.3 for piping System 20 specified in Section 40 27 05.

B. Welds for piping systems not specified above shall be made in accordance with AWWA C206.

3.03 TAKEDOWN COUPLINGS

A. Takedown couplings shall be screw unions, flanged or grooved end mechanical coupling type joints and shall be provided as specified. Flanged or grooved end joints shall be employed on pipelines 2-1/2 inches in diameter and larger. Where piping passes through walls, takedown couplings shall be provided within three feet of the wall, unless specified otherwise.

B. A union or flanged connection shall be provided within two feet of each threaded end valve.

3.04 FLEXIBILITY

Unless otherwise specified, piping passing from concrete to earth shall be provided with two pipe couplings or flexible joints (or a single Flexijoint) as specified on the buried pipe within two feet of the structure for 2-inch through 6-inch diameter pipe; within three feet of the structure for 8-inch through 24-inch diameter pipe; and within 1.5 pipe diameters of the structure for larger pipe. Where required for resistance to pressure, mechanical couplings shall be restrained in accordance with Chapter 13 of AWWA M11, including Tables 13-4, 13-5 and 13-5A, and Figure 13-20.

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3.05 DIELECTRIC CONNECTIONS

Where a copper pipe is connected to steel or cast iron pipe, an insulating section of rubber or plastic pipe shall be provided. The insulating section shall have a minimum length of 12 pipe diameters. Dielectric unions as specified in paragraph 40 27 05.04-2.05 may be used instead of the specified insulating sections. Where copper pipe is supported from hangers, it shall be insulated from the hangers, or copper-plated hangers shall be used.

END OF SECTION

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SECTION 40 27 05.06

EXPANSION JOINTS

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SECTION 40 27 05.06

EXPANSION JOINTS

PART 1 – GENERAL

1.01 DESCRIPTION

This section specifies piping expansion joints.

1.02 QUALITY ASSURANCE

A. References – This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced.

Reference	Title
ASTM A276	Stainless and Heat–Resisting Steel Bars and Shapes
EJMA STDS	Standards of Expansion Joint Manufacturers' Association, Edition No. 5

B. Selection Criteria – The selection and installation of expansion joints shall be in conformance with the expansion control system designed by the Design Professional, retained under the requirements of paragraph 40 27 05–1.01 A, and the criteria specified herein. This requirement, however, shall not be construed as relieving the Contractor of responsibility for this portion of the work.

C. Design Criteria:

1. General – Expansion joints shall be designed in accordance with EJMA Standards for pressure, temperature and service as specified in the Piping System Specification Sheets (PIPESPEC) without crimping of corrugations.

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2. Expansion Joints – Corrugated type expansion joints shall be suitable for a minimum of 10,000 pressure, temperature and deflection cycles (non-concurrent).

1.03 SUBMITTALS

The following submittals shall be submitted for approval:

A. Design and construction details of formed metal bellows type expansion joints.

B. Pressure thrust force and spring rate data for formed metal bellows expansion joints.

C. Details for installation of all expansion joints.

D. A copy of this specification section with addenda updates, and all referenced sections with each paragraph check marked to show specification compliance or marked to show deviations.

PART 2 – PRODUCTS

2.01 EXPANSION JOINTS

A. Metal Construction:

1. Formed Bellows Type:

a. Formed bellows type expansion joints for temperatures up to 800 ºF shall have 300 series stainless steel multi–ply bellows rated for the specified design temperature and pressure. Test pressures are specified in Section 40 27 05. Each expansion joint shall be factory tested at the test pressure. Ductwork expansion joints may be rated at less than 50 psig but must be rated equal to the design pressure and, in no case, less than 2 psig.

b. Expansion joint design shall be determined by the amount and kind of movement specified (axial, lateral, angular). Unless otherwise specified, end connections shall be flanged. Formed bellows type expansion joints shall be as manufactured by Flexonics, Inc., Hyspan Precision Products, Inc., American BOA Inc. or equal.

2. Steel Expansion Compensator Type – Steel expansion compensator type expansion joints shall be Flexonics Model H Expansion Compensator, Hyspan Series 8500, Keflex 7Q, or equal. Compensators shall have 2–ply stainless steel bellows and carbon steel shroud and end fittings. Compensators shall be rated for 175 psi maximum working pressure and 750 degrees F.

3. Bronze Expansion Compensator Type – Bronze expansion compensator type expansion joints shall be Flexonics Model HB Expansion Compensator,

Hyspan Series 8500, Keflex 7Q, American BOA Inc., or equal. Compensators shall have multi–ply phosphor bronze or stainless steel bellows and copper tube end fittings. Compensators shall be rated for 150 psi maximum working pressure and 400 ºF.

B. Elastomer and Fabric Construction:

1. General:

a. Elastomer and fabric expansion joints shall be the standard spool arch type or the precision molded spherical design type as indicated or specified. Expansion joint connectors shall have control units (restraints) to prevent excessive axial elongation and to accept the static pressure thrust in the piping system. Number and sizes of control rods or restraints shall be as determined by the manufacturer. Unless otherwise specified, single arch and sphere type expansion joints shall have 6–inch face–to–face dimension for pipe up to eight inches and 8–inch face–to–face dimension for pipe 10 and 12 inches.

b. The cover elastomer shall be chlorobutyl, neoprene or EPDM. For temperatures between 180 and 240 ºF, the tube elastomer shall be chlorobutyl or EPDM. Neoprene or Buna N liners are acceptable for temperatures to 180 ºF.

c. Elastomer and fabric type expansion joints used for exterior service shall have ultra–violet light protection.

d. Elastomer and fabric type expansion joints shall not be used for pump discharge piping and where surge forces may be expected.

2. Spool Type:

a. Spool type expansion joints shall be of the resilient arch type and shall be standard or tapered as specified. Unless otherwise specified, all tapered connectors shall be eccentric.

b. Spool type expansion joints shall be constructed of multiple plies of woven fabric impregnated with elastomer and reinforced with steel rings or wire embedded in the body. Standard arch type expansion joints suitable for the specified temperature and pressure shall be provided with retaining rings or backup rings. Retaining rings shall be 3/8–inch thick steel, split, either galvanized or zinc shield coated. Expansion joints, single, multiple, or filled arch, shall be Mason Style EJBN, Garlock Style 204, Mercer Style 500, Goodall Style E–1462, General Style 1025, or equal.

c. Filled arch type shall be used on all piping systems carrying fluids containing solids. High pressure couplings suitable for 240 ºF operating temperatures shall be Mason Style EJBN–HD, Mercer Style 510, Garlock Style 204–HP, Goodall Style E–1489, General Style 1015, or equal.

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3. Spherical Molded Type – Spherical molded type expansion joints shall be precision molded of multiple plys of nylon tire cord fabric and elastomer suitable for specified temperature and pressure. Spherical molded type expansion joints shall have steel or ductile iron floating flanges, and no metal parts shall come in contact with the fluid. Single sphere molded connectors shall be Mason Type MFNC, Mercer Type 5500, Goodall Type E–611, General Type 1010, Garlock Style 8100, or equal. Double sphere or triple sphere connectors shall be provided where required to provide for the specified movement.

C. Polyvinylchloride Construction - Polyvinylchloride expansion joints shall be Celanese "Chemtrol" CPVC slip type with Teflon impregnated seal rings, Certain–teed Fluid Tite PVC, Johns–Manville PVC double bell expansion joint, or equal.

D. Teflon Construction – Teflon expansion joints shall be molded TFE bellows and shall be Metraflex T–2, Garlock Style 215, Resistoflex R–6905, EGC Style M–150, or equal.

PART 3 – EXECUTION

3.01 INSTALLATION

A. Expansion joints and anchors shall be located as specified. Location and number of guides shall be determined from EJMA Standards.

B. Expansion joints shall not be installed during times of temperature extreme or in a fully compressed or fully expanded condition.

C. Unless otherwise specified, expansion joints four inches and larger shall be furnished with control rods.

3.02 ALIGNMENT

Piping systems shall be aligned prior to installation of expansion joints. Expansion joints shall not be used to correct piping misalignment during installations. Expansion joints normally preset at the factory for rated axial compression and expansion shall be installed in this preset condition.

3.03 EXPANSION JOINT AND CONNECTOR SCHEDULE

Expansion joints provided for specific equipment items or piping systems are specified on the following schedule. The location of piping system expansion joints and design criteria, including temperature, pressure and movement for each joint, are specified and/or shown on the drawings.

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Expansion Joint and Connector Schedule

Type of Expansion Joint/Connector	Type of Service/Use
Formed metal bellows; medium temperature (2.01 A.1.a.)	Boiler exhaust, hot water, high pressure air, and gas and steel lines subjected to ambient temperature differentials sufficient to require expansion joints.
Steel expansion compensator (2.01 A.2.)	Same type service/use as for "formed metal bellows type expansion joint" except size of piping is limited to 3-inch diameter or less.
Bronze expansion compensator (2.01 A.3.)	Copper piping.
Elastomer spool arch (2.01 B.2.)	Blower connectors and expansion joints for piping 14-inch diameter and larger.
Elastomer spherical molded (2.01 B.3.)	Blower connectors and expansion joints for piping 12-inch diameter and less.
PVC (2.01 C.)	PVC piping.
Teflon (2.01 D.)	RTRP (FRP) piping.
Teflon flexible connector (2.03)	Connection of PVC piping to chemical storage tanks.

[a] Excludes steam and chemical services.

END OF SECTION

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PIPING APPURTENANCES

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SECTION 40 27 05.08

PIPING APPURTENANCES

PART 1 – GENERAL

1.01 DESCRIPTION

A. SCOPE

1. This section specifies pipeline thermometers, flow and level gages, pressure gages, strainers, steam traps, vents, and drains.

B. EXCLUSIONS:

1. Temperature, pressure and flow measuring devices used for instrumentation are specified in Other Sections.

PART 2 – PRODUCTS

2.01 PIPELINE THERMOMETERS

A. GENERAL:

1. Pipeline thermometers shall be suitable for the 50 – 150 degrees Fahrenheit. Pipeline thermometers shall indicate fluid temperatures within the pipeline to an accuracy of plus or minus two percent of thermometer full scale.

2. Pipeline thermometers shall be provided with threaded thermowell mountings, designed to permit removal of the thermometer without depressurization or loss of process fluid. For insulated pipes a thermowell with a lagging extension shall be provided.

B. BIMETALLIC THERMOMETERS:

1. Unless otherwise specified, bimetallic type thermometers shall be of the adjustable angle type mounted for convenient viewing. Bimetallic thermometers shall have type 304 stainless steel case. Thermometer dials shall be a minimum of five inches in diameter and shall be equipped with an external adjustment mechanism for zero reset. Bimetallic thermometers shall be Ashcroft Type EH, Marsh Mastertherm, or equal.

C. FILLED THERMOMETERS:

Unless otherwise specified, filled type thermometers shall have minimum scale length of nine inches and shall be of the adjustable angle type mounted for convenient viewing. Filled thermometers shall consist of a type 304 stainless steel frame and a mercury-filled pyrex tube. The thermometer tube shall be recessed into the frame. Filled thermometers shall be Weksler, Taylor, or equal.

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2.02 FLOW AND LEVEL GAGES

A. ROTAMETERS:

1. Unless otherwise specified, rotameters for purges and other low capacity services shall be Brooks Sho-Rate "50," Wallace & Tiernan three-inch purge meter, Schutte & Koerting, or equal, with integral needle valve and flow controller. Meter tubes shall be glass, floats shall be stainless steel, and cases shall be aluminum or stainless steel. Unless otherwise specified, meter sizes shall be selected so that the flow rate recommended by the manufacturer of the purged equipment falls within the middle third of the meter scale. Units shall have a 3-inch minimum scale direct reading in the units of flow.

2. Rotameters for high capacity service shall be glass tube-type with a 5-inch scale and stainless steel frame. Flow range shall be as specified and scales shall indicate the units of flow. Rotameters shall be as manufactured by Brooks, Wallace & Tiernan, Schutte & Koerting, or equal.

B. SIGHT GAGES:

1. Sight gages shall be 3/4-inch Penberthy 205 Series, Lunkenheimer Fig. 589, or equal, automatic water gage complete with pyrex gage glass and gage glass protector. Overall length of gages, type of mounting, and orientation of set shall be as specified.

C. FLOW INDICATORS:

1. Flow indicators shall be provided where specified. Each indicator shall consist of a bronze body with threaded ends and a sight glass with rotary wheel. Pressure ratings for flow indicators shall match pipe pressure ratings. Indicators shall be as manufactured by Jacoby-Tarbox, Schutte & Koerting, Eugene Ernst Products, or equal.

2.03 PRESSURE DEVICES

A. GAGE COCKS:

1. Unless otherwise specified, gage cocks shall be Robertshaw 1303, Ashcroft 1095, or equal. The exposed threads of each gage cock shall be protected by a brass plug.

B. PRESSURE GAGES:

1. Unless otherwise specified, pressure gage scales shall be selected so that the normal operating pressure falls between 50 and 80 percent of full scale, shall be 4 1/2-inch, 270-degree movement, 1/2-percent accuracy, full-scale, and suitable for bottom stem mounting. Gages shall have a 316-SS bourdon tube. All gages shall have a 300 series stainless steel case, shatterproof glass, and a 1/2-inch NPT bottom connection.

2. Pressure gages for air, gas, and low pressure services (0-10 feet) shall be premium grade, heavy-duty bourdon-tube units (bellow type for vacuum) with Delrin bushings and pinion, and stainless steel sector.

3. Gages on liquid service shall be as noted above, except they shall be provided with an internal pulsation dampening system consisting of either a glycerin fill or a silicone fluid fill. Snubbers or orifices shall not be utilized. Gages shall be Ashcroft Duragauge Fig. 1279, Ametek 1981L, or equal.

C. DIAPHRAGM SEALS:

1. Unless otherwise specified, seals shall be diaphragm type with 1/4-inch flushing connection, Type 316 stainless steel body and Type 316L diaphragm. Fill fluid shall be Silicone DC200 unless otherwise specified. Seal shall be Mansfield and Green Type SG, Ashcroft Type 101, or equal.

D. PRESSURE SENSORS

1. Unless otherwise specified, pressure sensors (tubular chemical seals) shall be the in-line full stream captive sensing liquid type. Wetted parts shall be 316 stainless steel. Flexible cylinder shall be Buna-N unless otherwise specified. Seals shall be rated for 200 psi with five-inch SC hysteresis. Seals shall be Ronningen-Petter, Red Valve, or equal.

2. Fill fluid shall be rated for a temperature range of -20 degrees Fahrenheit to 200 degrees Fahrenheit. Capillary tubing shall be armored stainless steel. Fittings shall be provided for vacuum filling of system. Systems that are not factory filled shall be vacuum filled in the field. Filling connections shall be soldered shut after vacuum evacuation and filling.

2.04 STRAINERS

A. AIR AND GAS STRAINERS:

1. Unless otherwise specified, air and gas line strainers shall be Y-pattern, cast iron body, with 40 mesh Monel screens packed with Everdur wool. Bronze bodies shall be provided with copper piping. Air line strainers shall be fitted with a brass blow off cock. Strainers shall be Mueller, Armstrong, or equal.

B. STEAM AND WATER STRAINERS:

1. Steam and water strainers shall be of Y-pattern, unless otherwise specified. Steam strainers shall have carbon steel body; water strainers shall have cast iron body. Bronze bodies shall be provided with copper piping. Strainers shall have 304 stainless steel screens and tapped and plugged blow off connections. Screen perforations shall be 0.020 inch for steam service and 0.045 inch for water service. Strainers shall be Mueller, Armstrong, or equal.

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C. FUEL OIL STRAINERS:

1. Fuel oil strainers shall be of the basket type and shall have cast iron body with 304 stainless steel screens. Screen perforation shall be 3/64 inch. Strainers shall be Bailey No. 1, Mueller, or equal.

2.05 PRODUCT DATA

A. Manufacturer's product data shall submitted for approval.

PART 3 – EXECUTION

3.01 PIPELINE THERMOMETERS

A. Unless otherwise specified, filled thermometers shall be used on all water based services, and bimetallic thermometers shall be used for high temperature (300 degrees F or above) steam or gaseous services. Filled thermometers shall be installed where vibration or unstable mounting conditions exist. Thermometers shall be provided for all water and process stream inlets and outlets at each heat exchanger, heat extractor, and chiller; where shown, and adjacent to process taps for temperature sensing or transmitting instrumentation.

3.02 GAGE TAPS

A. Gage taps shall be provided on the suction and discharge of all pumps, fans, compressors, vacuum pumps and blowers. Gage taps shall consist of a 1/4-inch gage cock attached by a threaded nipple to the pipeline, duct or equipment.

3.03 VENTS AND DRAINS

A. Manual air vents shall be provided at the high points of each reach of pipeline where specified. Air vents shall consist of bronze cock and copper tubing return. Air vents shall be taken to the nearest floor with cock mounted four feet above the floor. Vents in piping systems for fluids containing solids shall be one-inch non–lubricated eccentric plug valves fitted with quick couplers.

B. Drains shall be piped to a sump, gutter, floor drain or other collection point with a valve mounted four feet above the floor. Drain valves shall be threaded end gate valves of the size specified. When drains cannot be run to collection points, they shall be routed to a point of easy access and shall have hose gate valves of the size specified.

END OF SECTION

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SECTION 40 27 05.09

INSULATION FOR EXPOSED PIPING AND EQUIPMENT

PART 1 – GENERAL

1.01 DESCRIPTION

A. SCOPE:

1. This section specifies insulation for exposed piping and related equipment and appurtenant surfaces.

2. All above ground lines require insulation (One-inch minimum. See table in 3.02 for specfics).

B. TEMPERATURE CLASSES:

Insulation for exposed piping and equipment is classified for the following temperature ranges: low, medium, high, and very high.

Low temperature class insulation shall be suitable for an operating temperature range of minus 100 to plus 100 degrees Fahrenheit.

Medium temperature class insulation shall be suitable for an operating temperature range of 100 to 800 degrees Fahrenheit.

High temperature class insulation shall be suitable for an operating temperature range of 800 to 1,200 degrees Fahrenheit. Very high temperature class insulation shall be suitable for an operating temperature range of 1,200 to 1,800 degrees Fahrenheit.

1.02 REFERENCES

A. This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

B. Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced.

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Reference	Title
ASTM B209	Aluminum and Aluminum–Alloy Sheet and Plate
ASTM C533	Calcium Silicate Block and Pipe Thermal Insulation
ASTM C534	Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form
ASTM C552	Cellular Glass Thermal Insulation
ASTM E96	Water Vapor Transmission of Materials
FEDSPEC L–P–535E	Plastic Sheet (Sheeting) "Plastic Strip" Poly (Vinyl Chloride) and Poly (Vinyl Chloride–Vinyl Acetate), Rigid
ASTM C547	Mineral Fiber Pipe Insulation

PART 2 –PRODUCTS

2.01 GENERAL

A. Piping insulation shall be tubular type or the flexible blanket type. Insulation for valves, strainers, fittings, expansion joints, flanges and other connections shall be segmented sections, molded, or blanket type coverings of the specified type and thickness of pipe insulation, or the flexible blanket type. Equipment insulation shall be flexible blanket type or rigid board type cut to fit the surface.

2.02 INSULATION

A. GENERAL:

1. Low temperature class insulation shall be of the unicellular elastomeric thermal, cellular glass, or fiberglass type.

2. Medium temperature class insulation shall be of the cellular glass or fiberglass type.

3. High temperature class and very high temperature class insulation shall be of the calcium silicate type or the flexible blanket type. Piping and equipment subjected to vibration (such as engine exhaust) shall be insulated with flexible blanket type.

B. UNICELLULAR ELASTOMERIC THERMAL TYPE:

1. Unicellular elastomeric thermal type insulation shall conform to the requirements of ASTM C534, Type I.

C. CELLULAR GLASS TYPE:

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1. Cellular glass type insulation shall conform to the requirements of ASTM C552, Type II.

D. FIBERGLASS TYPE:

1. Fiberglass type insulation shall conform to the requirements of ASTM C547, Type I, Grade A.

E. CALCIUM SILICATE TYPE:

1. Calcium silicate type insulation shall conform to the requirements of ASTM C533, Type II, Class C.

F. FLEXIBLE BLANKET TYPE:

1. HIGH TEMPERATURE CLASS: High temperature insulation shall be removable one–inch or two–inch thick blanket–type insulation designed for continuous 1,200 degree Fahrenheit service. The blanket shall be a custom sewn, flexible, reusable jacket, custom designed to closely fit the piping or the equipment housing. Blanket shall be custom fitted to not restrict access to any instrumentation or equipment. Insulation shall not compact or shake down in vibrating service. Blanket insulation shall consist of a noncombustible silica cloth jacket and nonasbestos white ceramic fiber insulation. Insulating blanket shall be Hitco AIM, Advanced Thermal Products, SEI Temp–Set 1200, or equal.

2. VERY HIGH TEMPERATURE CLASS: Very high temperature insulation shall be removable one–inch or two–inch thick blanket–type insulation designed for continuous 1,800 degree Fahrenheit service. The blanket shall be a custom sewn, flexible, reusable jacket, custom designed to closely fit the piping or the equipment housing. Blanket shall be custom–fitted to not restrict access to any instrumentation or equipment. Insulation shall not compact or shake down in vibrating service. Blanket insulation shall consist of a noncombustible silica cloth jacket and high purity alumina and silica nonasbestos white ceramic fiber insulation. Insulating blanket shall be Hitco AIM, Advanced Thermal Products, or equal.

2.03 INSULATION JACKETS

A. LAMINATED JACKETS:

1. Laminated jackets shall consist of aluminum and white kraft paper. Jackets shall have a perm rating for water vapor transmission of not more than 0.02 in accordance with procedure A of ASTM E96.

B. ALUMINUM JACKETS:

1. Aluminum jackets shall be constructed of smooth finish aluminum sheet conforming to ASTM B209, alloy 5005, 3003, or 3105, temper H16, with integral vapor barrier. Jackets shall be 0.016 inch thick.

2. Sheet metal screws shall be aluminum or stainless steel.

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3. Jackets shall be secured with 0.020 by 3/4 inch type 304 stainless steel expansion bands.

2.04 INSULATION COVERS

A. POLYVINYLCHLORIDE (PVC) COVERS:

1. Polyvinylchloride covers shall be one piece, premolded polyvinylchloride.

B. ALUMINUM COVERS:

1. Aluminum covers shall be constructed of smooth finish aluminum sheet conforming to ASTM B209, alloy 5005, 3003, or 3105, temper H16, with integral vapor barrier. Covers shall be 0.016 inch thick.

C. SOFT COVERS:

1. Soft covers shall be of the reusable type with TFE–coated fiberglass covers and liner.

2.05 SHIELDS

A. Unless otherwise specified, thermal pipe hanger shields shall be provided at pipe supports. Thermal hanger shields shall be as specified in Section 40 05 15.

2.06 FLASHING

A. Flashing shall include aluminum caps, sealant and reinforcing. Aluminum caps shall be 20 gage thick and shall be cut to completely cover the insulation. Sealants shall be as recommended by the insulation manufacturer.

B. Reinforcement in flashing heated up to 370 degrees Fahrenheit shall be nylon fabric. Reinforcement in flashing for hotter surfaces shall be wire mesh or as recommended by the insulation manufacturer.

2.07 PRODUCT DATA

A. The following information shall be submitted:

1. Manufacturer and manufacturer's type designation.

2. Samples, for each insulation material type, of typical jacket and closures for fittings, valves and appurtenances.

3. Descriptive literature and catalog data for materials to be used showing methods of installation.

4. Certification of ratings for water vapor transmission and puncture and stiffness as specified in paragraph 40 27 05.09–2.03 A.

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PART 3 – EXECUTION

3.01 INSTALLATION

A. GENERAL:

1. Insulation shall be applied over clean, dry surfaces. Double layer insulation, where specified or required to achieve the specified surface temperature, shall be provided with staggered section joints.

B. PIPE SUPPORTS AND SHIELDS:

1. Unless otherwise specified, thermal pipe hanger shields shall be provided by the Contractor and installed during pipe support installation. Where thermal pipe hanger shields are used, apply the following to all butt joints:

a. On hot pipe systems, the Contractor shall apply three–inch wide vapor barrier tape or band over the butt joints.

b. On cold water, chilled water, or refrigerant piping, the Contractor shall apply a wet coat of vapor barrier lap cement on all butt joints and seal the joints with a minimum 3–inch wide vapor barrier tape or band.

C. PROTECTION:

1. Insulation and jackets shall be protected from crushing, denting, and similar damage during construction. Vapor barriers shall not be penetrated or otherwise damaged. Insulation, jacket, and vapor barriers damaged during construction shall be removed and new material shall be installed.

D. PIPING INSULATION:

1. GENERAL:

a. PIPE: Piping shall be continuously insulated along its entire length including all in–line devices such as valves, fittings, flanges, couplings, strainers and other piping appurtenances. Unless otherwise specified, piping insulation shall be provided with laminated jackets specified in paragraph 40 27 05.09–2.03 A. Insulation shall be butted firmly together and jacket laps and joint strips provided with lap adhesive. Jackets shall be provided with their seams located on the underside of pipe.

1. PVC covers specified in paragraph 40 27 05.09–2.04 A shall not be used with medium– or high–temperature class insulation. Removable flexible blanket–type insulation need not be jacketed.

b. FITTINGS, CONNECTIONS, FLANGES AND VALVES: Fitting, connection, flange and valve insulation shall be provided with covers specified in

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paragraph 40 27 05.09–2.04. Insulation shall be secured in place with 20–gage wire and a coat of insulating cement. Covers shall overlap the adjoining pipe insulation and jackets. Covers shall be provided with their seams located on the underside of fittings and valves.

2. LOW TEMPERATURE CLASS:

a. PIPE: Insulation shall have ends sealed off with a vapor barrier coating.

b. FITTINGS, CONNECTIONS, FLANGES AND VALVES: Except where soft covers are specified, insulation for pipe sizes two inches and less, shall be provided with rigid PVC covers specified in paragraph 40 27 05.09–2.04 A. Covers shall be sealed at edges with vapor barrier adhesive. The ends of covers shall be secured with vinyl tape. The tape shall overlap the jacket and the cover at least one inch. Vapor barrier shall not be penetrated.

1. Except where soft covers are specified, insulation for pipes two and a half inches and larger shall be provided with rigid aluminum covers specified in paragraph 40 27 05.09–2.04 B. Covers shall be mechanically secured by corrosion–resistant tacks pushed into the overlapping throat joint.

3. MEDIUM, HIGH, AND VERY HIGH TEMPERATURE CLASS:

a. PIPE: Except for flexible blanket type, insulation shall have ends sealed with end joint strips and held in place by waterproof adhesive.

b. FITTINGS, CONNECTIONS, FLANGES AND VALVES: Except where soft covers are specified, rigid insulation shall be provided with rigid aluminum covers specified in paragraph 40 27 05.09–2.04 B. Covers shall be mechanically secured by corrosion–resistant tacks pushed into the overlapping throat joint.

4. OUTDOOR PIPING:

a. PIPE: Rigid insulation shall be provided with aluminum jackets specified in paragraph 40 27 05.09–2.03 B. Flexible blanket–type insulation shall be designed for outdoor, weather–exposed service.

b. FITTINGS, CONNECTIONS, FLANGES AND VALVES: Rigid insulation shall be provided with rigid aluminum covers specified in paragraph 40 27 05.09–2.04 B. Flexible blanket type insulation shall be designed for outdoor, weather–exposed service.

E. MECHANICAL EQUIPMENT INSULATION:

1. GENERAL: Unless otherwise specified, insulation shall fit the contours of equipment and shall be secured with 1/2 by 0.015 inch galvanized steel bands. Weld pins or stick clips with washers may be used for flat surfaces

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and spaced a maximum 18 inches apart. Joints shall be staggered and voids filled with insulating cement. Unless otherwise specified, insulation shall be provided with laminated jackets specified in paragraph 40 27 05.09–2.03 A.

a. Unless specifically specified to be uninsulated, equipment connected to insulated piping shall be insulated.

2. OUTDOOR EQUIPMENT: Insulation shall be provided with a coat of weatherproof mastic and a layer of open–weave glass cloth embedded into a wet tack coat. Seams shall overlap at least two inches. A finish coat of weatherproof mastic shall be provided. The total coating thickness shall be a minimum of 1/8-inch.

3. LOW TEMPERATURE CLASS: Insulation shall have joints, breaks, and punctures sealed in facing with fire–retardant vapor barrier adhesive reinforced with four–inch tape.

   Insulation shall be provided with a layer of open–weave glass cloth embedded into a wet coat of fire–retardant adhesive. Seams shall overlap at least two inches. A finish coat of fire–retardant adhesive shall be provided.

4. MEDIUM TEMPERATURE CLASS: Joints shall be covered and cemented in place with four–inch–wide strips of the same material as the laminated jackets specified in paragraph 40 27 05.09–2.03 A.

5. HIGH AND VERY HIGH TEMPERATURE CLASS: High and very high temperature equipment shall be covered with custom–fitted removable blanket–type insulation. Blanket–type insulation shall be secured with stainless steel wire lacing and hooks. Ends of blanket segments shall overlap to prevent gaps and voids when the piping and equipment is heated. Blankets shall be snugly secured under nuts and bolt heads to assure complete coverage during operation and to prevent vibration–induced gaps or voids. Blankets shall be secured in strict accordance with the manufacturer's instructions.

F. FLASHING:

1. Flashing shall be provided at jacket penetrations and terminations. Clearance for flashing shall be provided between insulation system and piping supports.

2. A heavy tack coat of sealant shall be troweled over the insulation, extending over the jacket edge 1 inch and over the pipe or protrusion 2 inches. Reinforcement shall be stretched over the tack coat after clipping to fit over pipe and jacket. Clipped reinforcing shall be strapped with a continuous band of reinforcing to prevent curling. Sealant shall then be troweled over the reinforcement to a minimum thickness of 1/8-inch.

3. Aluminum caps shall be formed to fit over the adjacent jacketing and to completely cover coated insulation. Cap shall be held in place with a jacket strap.

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3.02 INSULATION THICKNESS SCHEDULE

A. The insulation dimensional tolerances shall comply with the specified standards. Equipment insulation shall match thickness of attached piping. The minimum insulation thicknesses, exclusive of jacket, shall be as follows:

Piping service	Fluid temperature range, degrees F	Insulation thickness in inches for nominal pipe sizes					
		Runouts up to 2 inches	1 inch and less	1.25 to 2 inches	2.50 to 4 inches	5 and 6 inches	8 inches and larger
Cooling:							
Refrigerant	25–40	1.0	1.0	1.0	1.0	–	–
Process:							
Water & similar	60-100	1.0	1.0	1.5	1.5	1.5	2.0
PA, CA[f]	150–250	1.0	1.0	1.5	1.5	1.5	–
NaOH	60 – 100	1.0	1.0	1.0	–	–	–

[a] See specification Section 40 27 05.
[b] Runouts to individual terminal units (not exceeding 12 feet in length).
[c] Refrigerant insulation by air conditioning equipment supplier.
[f] Insulate piping for personnel protection between compressor and after cooler only. Include drip legs.
[g] For condensation control, see specification Section 40 27 05. Unless otherwise specified, connected equipment shall be uninsulated.
h All above ground lines require a 1-inch minimum thick insulation.

END OF SECTION

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SECTION 40 29 01

MANUAL VALVE AND GATE OPERATORS AND OPERATOR APPURTENANCES

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SECTION 40 29 01

MANUAL VALVE AND GATE OPERATORS AND OPERATOR APPURTENANCES

PART 1 – GENERAL

1.01 DESCRIPTION

A. This section specifies manual operators for valves and gates, and operator appurtenances.

1.02 REFERENCES

A. This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

B. Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced.

Reference	Title
AWWA C500	Gate Valves 3 through 48 inch NPS, for Water and Sewage Systems

PART 2 – PRODUCTS

2.01 GENERAL

A. Except as specified in valve and gate specification sections, manual operators shall be as specified herein. Operators shall be mounted on the valve or gate and provided as a unit. Each valve body or operator shall have cast thereon the word "OPEN," an arrow indicating the direction to open, and flow direction arrows.

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2.02 OPERATORS

A. GENERAL:

1. Manual operators shall have operating torques less than 80 foot–pounds. Unless specified otherwise, each manual operator shall be provided with an operating wheel. Unless specified otherwise, the direction of rotation of the operator shall be counterclockwise for opening.

B. WRENCH NUTS:

1. Wrench nuts shall comply with Section 3.15 of AWWA C500. A minimum of two operating keys, but no less than one key per every ten valves, shall be provided for operation of the wrench nut operated valves.

C. CHAIN WHEELS:

1. Chain wheels shall be ductile iron. Operating chains shall be galvanized.

2.03 OPERATOR APPURTENANCES

A. VALVE BOXES:

1. Valve boxes shall be cast iron and shall have suitable base castings to fit properly over the bonnets of their respective valves and heavy top sections with stay–put covers.

B. FLOOR BOXES:

1. Floor boxes shall be hot–dip galvanized. Where the operating nut is in the concrete slab, the floor box shall be bronze bushed. Where the operating nut is below slab, the opening in the bottom of the box shall be sufficient for passage of the operating key.

C. ADJUSTABLE SHAFT VALVE BOXES:

1. Adjustable shaft valve boxes shall be concrete or cast iron Brooks No. 3RT, Christie G5, Empire 7–1/2 valve extension box, or equal. Box covers on water lines shall be impressed with the letter "W." Gas line covers shall be impressed with the letter "G."

2.04 PRODUCT DATA

A. Manufacturer's catalog information and other data confirming conformance to design and material requirements shall be provided.

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PART 3––EXECUTION

3.01 GENERAL

A. Installation shall be as specified herein. Valve operators shall be located so that they are readily accessible for operation and maintenance. Valve operators shall be mounted for unobstructed access, but mounting shall not obstruct walkways. Valve operators shall not be mounted where shock or vibration will impair their operation. Support systems shall not be attached to handrails, process piping, or mechanical equipment.

3.02 OPERATORS

A. GENERAL:

1. Valves and gates shall be provided with manual operators, unless specified otherwise. Where possible, manual operators shall be located between 48 inches and 60 inches above the floor or a permanent work platform.

B. WRENCH NUTS:

1. Wrench nuts shall be provided on buried valves, on valves which are to be operated through floor boxes, and where specified. Extended wrench nuts shall be provided if necessary so that the nut will be within six inches of the valve box cover.

C. CHAIN WHEELS:

1. Unless otherwise specified, valves with centerlines more than seven feet, six inches above the specified operating level shall be provided with chain wheels and operating chains. Chain wheel operated valves shall be provided with a chain guide. Operating chains shall be looped to extend within four feet of the specified operating level below the valve. For plug–type valves eight inches and larger, the operator shall be provided with a hammer blow wheel. Hooks shall be provided for chain storage where the chain may hang in a walkway.

3.03 OPERATOR APPURTENANCES

A. VALVE BOXES:

1. Valve boxes extending to finished surfaces shall be provided for buried valves.

B. FLOOR BOXES:

1. Floor boxes shall be provided for wrench operation of valves located below concrete slabs. Each floor box and cover shall be of the depth required for installation in the slab.

END OF SECTION

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SECTION 40 29 13

BUTTERFLY VALVES

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SECTION 40 29 13

BUTTERFLY VALVES

PART 1 – GENERAL

1.01 DESCRIPTION

A. SCOPE:

1. This section specifies butterfly valves for air, gas, steam, and water service.

1.02 REFERENCES

A. This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

B. Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced.

Reference	Title
ANSI B16.1	Cast Iron Pipe Flanges and Flanged Fittings Class 25, 125, 250 and 800
ANSI B16.5	Pipe Flanges and Flanged Fittings
ASTM A48	Gray Iron Castings
ASTM A108	Steel Bars, Carbon, Cold–Finished, Standard Quality
ASTM A126	Gray Iron Castings for Valves, Flanges, and Pipe Fittings
ASTM A216/A216M	Steel Castings, Carbon, Suitable for Fusion Welding, for High Temperature Service
ASTM A276	Stainless and Heat–Resisting Steel Bars and Shapes
ASTM A436	Austenitic Gray Iron Castings
ASTM A536	Ductile Iron Castings
AWWA C504	Rubber–Seated Butterfly Valves

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PART 2 – PRODUCTS

2.01 MATERIALS

A. Valves specified for use in Water shall be considered TYPE A and shall be constructed of the following materials unless otherwise specified:

Component	Material
Shaft	Stainless steel, ASTM A276, Type 304 Carbon steel, ASTM A108, with stainless steel journals
Disc	Ductile iron, ASTM A536, or cast iron, ASTM A436, type 1 (Ni–Resist); or ASTM A48, Class 40, or ASTM A126, Class B
Seat mating surface	Stainless steel, ASTM A276, Type 304, mounted in body or on disc edge; or Ni–Chrome on the disc edge
Seat sealing surface	Neoprene, EPDM or Buna N
Body	Cast iron, ASTM A126, Class B

B. Valves specified for use in Air shall be considered TYPE B and shall be constructed of the following materials unless otherwise specified:

Component	Material
Shaft	Stainless steel, ASTM A582, Type 416
Disc	Cast iron, ASTM A126, Class B
Seat sealing surface	Neoprene or Buna N—air and gas services Nordel—(high temp water)
Body	Cast iron, ASTM A126, Class B
Disc edge	Nickel

2.02 MANUFACTURE

A. GENERAL:

1. Valves shall be the stub or through shaft design. Wafer type valves are not acceptable for buried service. Unless otherwise specified, valve flange drilling shall be per ANSI B16.1, Class 125.

B. TYPE A:

1. Type A valves shall be designed in accordance with AWWA C504. Shafts shall be turned, ground and polished. Shaft dimensions and operator torque shall be chosen for the pressure specified in Section 40 27 05 and Class B as specified in AWWA C504. When carbon steel shafts and stainless steel journals are used, static seals shall be provided to isolate the interior of the disc and the shaft from the process fluid.

2. Type A valves, size 3 through 72 inches, shall have seats that are vulcanized, bonded, mechanically secured, or clamped to the body or disc.

C. TYPE B:

1. Valves shall be rated at 175 psig and provide drip tight shutoff up to the full valve rating on dead–end or isolation service. Seat shall be mechanically held in place and shall be field replaceable. Valve ends shall be as specified in Section 40 27 05.

2. Type B valves, size 2 through 20 inches, shall have seats that are bonded to a rigid reinforcing ring.

2.03 MANUAL OPERATORS

A. GENERAL:

1. Manual operators shall be designed in accordance with AWWA C504 and shall have a disc position indicator designating the opened and closed position of the valve.

B. TYPE A:

1. Manual operators for Type A valves shall be of the traveling nut, rack, and pinion, or worm gear type. Operators shall be equipped with adjustable mechanical stop–limiting devices to prevent over travel of the disc in the open and closed positions and shall be self–locking and designed to hold the valve in any intermediate position between full open and full closed. Valve operator components shall withstand an input torque of 300 ft.–lbs. at the extreme operator positions without damage.

2. Operator for buried service shall include an AWWA operating nut and shall be gasketed and grease packed for submerged operation at water pressures to 10 psig. Operators for exposed service shall include a hand wheel and be gasketed for weatherproof service.

C. TYPES B:

1. Operators for Type B valves six inches in diameter and smaller shall be latch lock levers. Valves shall be capable of being locked in at least five intermediate positions between fully open and fully closed.

2.04 PRODUCT DATA

A. Affidavits of compliance with AWWA C504 for Type A valves shall be provided.

PART 3 – EXECUTION

3.01 INSTALLATION

A. Valves shall be installed in accordance with the manufacturer's recommendations.

END OF SECTION

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SECTION 40 29 19

ECCENTRIC PLUG VALVES

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SECTION 40 29 19

ECCENTRIC PLUG VALVES

PART 1 – GENERAL

1.01 DESCRIPTION

This section specifies eccentric plug valves.

1.02 QUALITY ASSURANCE

A. References – This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced.

Reference	Title
ANSI B16.1	Cast Iron Pipe Flanges and Flanged Fittings Class 25, 125, 250, and 800
ASTM A126	Gray Iron Castings for Valves, Flanges, and Pipe Fittings
ASTM A276	Stainless and Heat–Resisting Steel Bars and Shapes
ASTM A436	Austenitic Gray Iron Castings
ASTM A536	Ductile Iron Castings
AWWA C504	Rubber Seated Butterfly Valves

B. Proof of Design Tests – The Contractor shall furnish the Construction Manager and Engineer of Record three certified copies of a report from an independent testing laboratory certifying successful completion of proof–of–design testing conducted in accordance with AWWA C517–05, except that where the word "disc" appears in the standard, it is understood to mean "plug." In lieu of testing the valves at an independent testing laboratory, proof–of–design testing may be performed at the valve manufacturer's laboratory, but must be witnessed by a representative of a qualified independent testing laboratory, and all test reports must be certified by

the laboratory representative. Proof–of–design testing shall have been performed on not less than three 6–inch diameter valves, with all three test units demonstrating full compliance with the test standards. Failure to satisfactorily complete the test shall be deemed sufficient evidence to reject all valves of the proposed make or manufacturer's model number.

PART 2 – PRODUCTS

2.01 MATERIALS

Materials of construction shall be as follows:

Component	Material
Body	Cast iron, ASTM A126, Class B
Plug	Cast iron, ASTM A126, Class B, or cast iron ASTM A436 (Ni–resist), or ductile iron, ASTM A536
Plug facing	Neoprene or Buna–N
Body seats	
Less than 3 inches	Cast iron, ASTM A126, Class B
3 inches and larger	Stainless steel, ASTM A276, Type 304 or nickel
Packing	Buna V–flex or TFE

Materials specified are considered the minimum acceptable for the purposes of durability, strength, and resistance to erosion and corrosion. The Contractor may propose alternative materials for the purpose of providing greater strength or to meet required stress limitations. However, alternative materials must provide at least the same qualities as those specified for the purpose.

2.02 MANUFACTURER

A. General – Valves shall be straight–flow, non–lubricated, resilient plug type suitable for drip-tight, bi–directional shutoff at the specified valve design pressure. Port areas for the valve shall be at least 80% of the adjacent full pipe area. Valve body seats consisting of nickel for valves three inches and larger shall be constructed of a welded–in overlay of not less than 90% pure nickel. Upper and lower journal bearings shall be replaceable, sleeve–type, corrosion resistant, and permanently lubricated. Packing shall be self–adjusting, chevron-type, replaceable without disassembling the valve.

Unless otherwise specified, valves shall, as a minimum, conform to the following pressure ratings:

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Size, inches	Design pressure, psig
12 and smaller	175
14 through 36	150
42 through 54	125

B. End Connections – Valves three inches and smaller shall have threaded ends. Valve flange drilling for valves larger than three inches shall be per ANSI B16.1, Class 125. Grooved–end valves may be provided with grooved–end piping systems.

C. Manual Operators – Unless otherwise specified, valves four inches and smaller shall be provided with a lever type manual operator. Valves larger than four inches shall be provided with totally enclosed worm gear operators. Where specified, manual operators shall have an adjustable stop. All operator components shall be sized for the valve design pressure in accordance with AWWA C504, Section 4.5. Operators shall comply with applicable portions of Section 40 29 01.

2.03 PRODUCT DATA

The following information shall be provided:

A. Manufacturer's product data.

B. Proof–of–design test reports specified in paragraph 40 29 19–1.02 B.

PART 3 – EXECUTION

Unless otherwise specified, valves shall be provided with the seat downstream away from flow. Valves at tank connections shall be installed with seat away from tank. Valves on pump discharge lines shall be installed with seat adjacent to the pump.

END OF SECTION

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SECTION 40 29 27

NONCLOG BALL CHECK VALVE

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SECTION 40 29 27

NONCLOG BALL CHECK VALVE

PART 1 – GENERAL

1.01 DESCRIPTION

A. SCOPE:

1. This section specifies nonclog ball check valves.

B. TYPE:

1. The nonclog check valves shall consist of three components: body, cover, and ball—one moving part. The design of the valve shall keep solids, stringy material, grit, rags, etc., moving without the need for backflushing. The ball shall clear the waterway providing "full flow" equal to the nominal size. There shall be no outside levers, weights, springs, dashpots, or other accessories.

1.02 REFERENCES

A. This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

B. Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced.

Reference	Title
ANSI B16.1	Cast Iron Pipe Flanges and Flanged Fittings Class 25, 125, 250, and 800

PART 2 – PRODUCTS

2.01 MANUFACTURERS

A. The following candidate manufacturers are capable of producing equipment and/or products that will satisfy the requirements of this Section. This statement, however, shall not be construed as an endorsement of a particular manufacturer's products, nor shall it be construed that named manufacturers' standard equipment or products will comply with the requirements of this Section. Candidate manufacturers include Flygt and Golden Anderson, or equal.

2.02 COMPONENTS

A. BODY AND COVER:

1. Valve body and cover shall be of gray cast iron or ductile iron. Flange drilling shall be according to ANSI B16.1, Class 125.

B. BALL:

1. The valve ball shall be hollow steel with an exterior of nitrile rubber. It shall be resistant to grease, petroleum products, animal and vegetable fats, diluted concentrations of acids and alkalines (pH 4 to 10), tearing, and abrasion.

2.03 PRODUCT DATA

A. Submit product information and applicable operation and maintenance information for review.

PART 3 – EXECUTION

3.01 INSTALLATION

A. Installation shall be in accordance with manufacturer's recommendations.

END OF SECTION

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SECTION 40 29 50

SPECIALTY VALVES

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SECTION 40 29 50

SPECIALTY VALVES

PART 1 – GENERAL

1.01 DESCRIPTION

A. This section specifies specialty valves which are auxiliary to process piping systems.

1.02 REFERENCES

A. This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

B. Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced.

Reference	Title
ASME SEC VIII D2	Boiler and Pressure Vessel Code, Pressure Relief Devices
ASTM A126	Gray Iron Castings for Valves, Flanges, and Pipe Fittings

PART 2 – PRODUCTS

2.01 MUD VALVES

A. Mud valves shall be of the heavy duty flange type with rising or non-rising stems as shown on the plans. Frame, cover, yoke and stem extension connection shall be stainless steel. Stems shall be stainless steel. Lift nuts shall be bronze. On non-rising stem models the stem is to be protected by a stainless steel shroud with drain hole. Valve shall be operated by a tee handle, hand wheel, or with stainless (mild steel) stem extension to the height required. On rising stem valves, stem guides shall be provided such that the L/R ratio of the unsupported part of the stem shall not exceed 200. Pedestal lifts, stem guides, and wall brackets shall be furnished by mud

valve manufacturer to make a complete and operable unit. Mud valves shall be Waterman MV–11, Trumbull 367-1351 or equal.

2.02 PRESSURE RELIEF VALVES

A. Pressure relief valves for air shall be ASME certified, Watts Fig 41A, Lonergan L14/L40 Series, or equal. Size and pressure settings shall be as specified or as required for the service intended. Pressure relief valves for cold and hot water shall be McDonnell and Miller 230, Watts 174A, Cash Acme F–82, Lonergan L14/L40 Series, or equal.

2.03 HOSE VALVES

A. Unless specified otherwise, hose valves shall be a brass angle valve, composition disc, Crane 17, Lunkenheimer 214, Powell 151, or equal with threaded nipple adapter for hose connection.

2.04 FLUSHING COCKS

A. Flushing cocks shall consist of a DeZurik 159/118–S, Keystone Fig 541, or equal, neoprene–faced eccentric plug valve with a hose nipple adapter if required. Unless specified otherwise, flushing cocks shall be 1 inch in diameter.

2.05 QUICK DISCONNECTS

A. Quick disconnects shall not be disconnectable under pressure. Quick disconnects for air service shall be Swagelok, Tomco, or equal, and shall be 1/2 inch, unless otherwise specified. Quick disconnects for water service shall be EverTite Part B, Gate Part B, or equal, and shall be 1 inch, unless specified otherwise.

2.06 PRODUCT DATA

A. Provide product data for approval.

PART 3 – EXECUTION

3.01 EXECUTION

A. Specialty valves shall be installed in accordance with the manufacturer's recommendations.

END OF SECTION

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SECTION 40 31 00

FABRICATED STAINLESS STEEL SLIDE GATES

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SECTION 40 31 00

FABRICATED STAINLESS STEEL SLIDE GATES

PART 1 – GENERAL

1.01 DESCRIPTION

A. SCOPE:

This section specifies self–contained Stainless Steel Downward Opening Weir Gates and gate operators.

B. TYPE:

Slide gates shall be of fabricated stainless steel construction, with gates, guides, and operators provided by one manufacturer. Gates shall meet the leakage requirements of AWWA C513.

The equipment provided under this section shall be fabricated, assembled, erected, and placed in proper operating condition in full conformity with the drawings, specifications, engineering data, instructions and recommendations of the equipment manufacturer unless exceptions are noted by the engineer.

Gates and operators shall be supplied with all the necessary parts and accessories indicated on the drawings, specified or otherwise required for a complete, properly operating installation and shall be the latest standard product of a manufacturer regularly engaged in the production of water control gates.

C. DESIGN CONDITIONS:

Self–contained slide gates shall be designed for continuous exposure to raw municipal wastewater. Fluid temperature is expected to range from 60 degrees F to 80 degrees F. The gates will be installed outdoors in a municipal wastewater treatment plant near the ocean.

D. OPERATING REQUIREMENTS:

Equipment number	Gate size, inch (a)	Gate type (b)	Opening direction (c)	Bottom seating (d)	Design head, feet		Operator type (e)
					Seating	Unseating	
WEG–050101	24 x 18	W	D	J	1	0	HW
WEG–050201	24 x 18	W	D	J	1	0	HW
WEG–230101	24 x 18	W	D	J	1	0	HW
WEG–230102	24 x 18	W	D	J	1	0	HW

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Notes:

[a] Width by height.
[b] C = channel–mounted, W = wall–mounted
[c] U = upward, D – downward
[d] FB = flush bottom, J = J–seal on invert
[e] GC = geared crank type, HW = hand wheel type

1.02 QUALITY ASSURANCE

A. REFERENCES:

This section contains references to the following documents. They are a part of this section as specified and modified. In case of a conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

Unless otherwise specified, references to documents shall mean the documents in effect at the time of Notice Inviting Bids. If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, whether or not the document has been superseded by a version with a later date, discontinued or replaced.

Reference	Title
ASME	American Society of Mechanical Engineers
ASTM 240	Heat–Resisting Chromium and Chromium Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels
ASTM A276	Stainless and Heat–Resisting Steel Bars and Shapes
ASTM D1248	Polyethylene Plastics Molding and Extrusion Materials for Wire and Cable
ASTM D2000	Rubber Products in Automotive Applications
ASTM D4020	Ultra–High–Molecular–Weight Polyethylene Molding and Extrusion Materials
AWWA C513	Open–Channel, Fabricated Metal Slide Gates

B. SUBMITTALS:

The following information shall be submitted for approval:

1. A copy of this specification section, with addendum updates included, and all referenced and applicable sections, with addendum updates included, with each paragraph check–marked to indicate specification compliance or marked to indicate requested deviations from specification requirements.

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Check marks shall denote full compliance with a paragraph as a whole. If deviations from the specifications are indicated, and therefore requested by the Contractor, each deviation shall be underlined and denoted by a number in the margin to the right of the identified paragraph, referenced to a detailed written explanation of the reasons for requesting the deviation. The Engineer shall be the final authority for determining acceptability of requested deviations. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the specifications. Failure to include a copy of the marked–up specification sections, along with justification(s) for any requested deviations to the specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.

2. Fabrication drawings with full dimensions.

3. Plan, cross section, and details showing proposed mounting for each size and typical application of gate.

C. MANUFACTURING:

Manufacturer's welders shall be certified per ASME, Section 1X or American Welding Society.

D. EXPERIENCE:

Manufacturer shall have a minimum of ten years' experience with the fabrication of the model of gate provided. Submit installation list of the model of gate provided to confirm this requirement.

PART 2––PRODUCTS

2.01 PRODUCTS

Fabricated stainless steel weir gates shall be Whipps, Hydro Gate, Rodney Hunt, Fontaine, Waterman, or equal, modified as necessary to provide the specified features and to meet the specified operating conditions.

2.02 MATERIALS

Materials for components shall be as follows:

Component	Material
Frames, slides, rails, and yokes	ASTM A276 or ASTM A240, Type 316L Stainless Steel
Fasteners and anchor bolts	ASTM A276, Type 316 Stainless Steel
Stems	ASTM A276, Stainless Steel, Type 304, 303 MX, or 316

Component	Material
Stem Guides	ASTM A276, Stainless Steel, Type 304L or 316L, with bronze or UHMW Polyethylene bushing
Seals	ASTM D2000, Grade AA625, Buna–N or neoprene rubber, or ASTM D4020 UHMW Polyethylene

2.03 EQUIPMENT FEATURES

A. GENERAL DESIGN. Weir gates shall be self–contained, and of the rising stem or non–rising stem configuration. Design stresses shall not exceed the lesser of 40% of the yield strength or 25% of the ultimate strength of the materials at maximum load conditions. Minimum thickness of slide, its reinforcing members, and all structural components of the guide and frame shall be 0.25 inches.

B. FRAME. The gate frame shall be constructed of structural members or formed plate welded to form a rigid one–piece frame. The frame shall be of the flange back design, suitable for mounting on a concrete wall (CW). The guide slot shall be made of UHMWPE (ultra high molecular weight polyethylene).

C. SLIDE. The slide shall consist of a flat plate reinforced with formed plates or structural members to limit its deflection to 1/720 of the gate's span under the design head. The gate frame shall be a rigid, welded unit, composed of the guide rails, cross bars, and deadrails, with a clear opening the same size as the waterway, unless otherwise specified. They shall be integral flange back or embedded type. The guides will be of sufficient length to support two–thirds (2/3) the height of the slide, when the gate is fully open. On wall mounted gates, compressible gaskets or grout shall be provided between frame and wall as needed to ensure full mating of surfaces and no leakage.

Where the guides extend above the operating floor, they shall be sufficiently strong so that no further reinforcing will be required. The yoke to support the operating device shall be formed by members welded or bolted at the top of the guides. The arrangement of the yoke shall be such that the slide and stem can be removed without disconnecting the yoke. When the slide is too long to allow this, the yoke shall be bolted for easy removal.

D. GUIDES AND SEALS. The guides shall be made of UHMWPE (ultra high molecular weight polyethylene) and shall be of such length as to retain and support at least two thirds (2/3) of the vertical height of the slide in the fully open position.

The bottom and side seals shall be made of UHMWPE (ultra high molecular weight polyethylene) of the self–adjusting type. A continuous compression cord shall ensure contact between the UHMWPE guide and the gate in all positions. The sealing system shall maintain efficient sealing in any position of the slide and let the water flow only in the open part of the gate.

Seals shall maintain the specified leakage rate in both seating and unseating conditions.

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E. OPERATOR STEM AND COUPLINGS. The operating stem shall be of stainless steel designed to transmit in compression at least two (2) times the rated output of the operating manual mechanism with a 40 lbs (178 N) effort on the crank or hand wheel.

The stem shall have a slenderness ratio (L/r) less than 200. The threaded portion of the stem shall have machine cut threads of the Acme type.

For stems in more than one piece and with a diameter of 1 ¾ inches (45 mm) and larger, the different sections shall be joined together by solid bronze couplings. Stems with a diameter smaller than 1 ¾ inches, shall be pinned to an extension tube.

The couplings shall be grooved and keyed and shall be of greater strength than the stem.

Gates having width equal to or greater than two times their height shall be provided with two lifting mechanisms connected by a tandem shaft.

F. STEM GUIDES. Stem guides shall be fabricated from type 304L (or 316L) stainless steel. The guide shall be equipped with an UHMWPE bushing. Guides shall be adjustable and shall be spaced in accordance with the manufacturer's recommendation. The L/r ratio shall not be greater than 200.

G. STEM COVER. Rising stem gates shall be provided with a clear polycarbonate stem cover. The stem cover shall have a cap and condensation vents as well as a clear mylar position indicating tape. The tape shall be field applied to the stem cover after the gate has been installed and positioned.

H. LIFTING MECHANISM. Manual operators of the types listed in the schedule shall be provided by the gate manufacturer.

Operators shall be hand wheel type. Operators shall meet AWWA C501 specifications, except as otherwise specified. Gears, and bearings shall be enclosed in a weatherproof housing, and pressure type fittings shall be provided for grease lubrication of the bearings and gears. A maximum effort of 40 pounds pull of the crank or hand wheel shall operate the gate under the specified operating conditions.

The operator shall be either pedestal or bench mounted as specified. Pedestal type floor standards shall be the offset type or the standard type with wall mounting bracket. Pedestal or bench stands shall be cast iron. The head of the pedestal or bench stand operator shall have a solid bronze, internally threaded operating nut. The operator shall be mounted on anti friction roller bearings. Cranks and handwheels shall be removable from the operator. Hand crank operators shall be provided with a 2–inch AWWA operating nut in horizontal appropriate for use with portable electric operators.

I. YOKE. Self–contained gates shall be provided with a yoke made of structural members or formed plates. The maximum deflection shall be 1/360 of the gate's span. The yoke shall be sufficiently strong to support the lift forces when subjected to a load of 100 pounds pull on the operator. The yoke shall be designed so that its

deflection under full operating load will not exceed 1/360 of the gate width.

J. MATERIALS

PART	MATERIAL
Frame, yoke, stem guides, slide, stem extension	Stainless steel ASTM A–240 type 304L or 316L
Guides, side and bottom seals, stem guide liner	Ultra high molecular weight polyethylene (UHMWPE) ASTM D–4020
Compression cord	Nitrile ASTM D2000 M6BG 708, A14, B14, E014, E034
Threaded stem	Stainless steel ASTM A–276 type 303 MX or 316
Fasteners	ASTM F593 and F594 GR1 for type 304 and GR2 for type 316
Pedestal, hand wheel and crank	Tenzaloy aluminum
Gasket (between frame and wall)	EPDM ASTM 1056
Stem cover	Polycarbonate ASTM D–3935
Lift nut, couplings	Manganese bronze ASTM B584 UNS–C86500

2.04 PRODUCT DATA

The following information shall be submitted for approval:

1. Product information, charts, or graphs to verify that the product provided meets the requirements set forth in the specification.

2. Affidavits of compliance in accordance with AWWA C513.

3. Applicable operation and maintenance.

PART 3––EXECUTION

3.01 INSTALLATION

Unless otherwise specified, self–contained slide gates shall be installed in accordance with manufacturer's instructions.

3.02 TESTING

For purpose of this specification, field leakage tests shall be performed as specified in Section 6.3 of AWWA C513.field leakage tests shall be conducted with no head on one side of the gate being tested.
Gate shall be operated through a minimum of two cycles, to confirm operation. Limit switches and other stops shall be adjusted per the manufacturer’s recommendations.

END OF SECTION

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SECTION 40 80 01

PROCESS PIPING LEAKAGE TESTING

PART 1 – GENERAL

1.01 SUBMITTALS

A. Information Submittals:

1. Testing Plan: Submit prior to testing and include at least the information that follows.

   a. Testing dates.
   b. Piping systems and section(s) to be tested.
   c. Test type.
   d. Method of isolation.
   e. Calculation of maximum allowable leakage for piping section(s).

2. Certifications of Calibration: Testing equipment.

3. Certified test report.

1.02 QUALITY ASSUERNCE

A. Testing shall be by a testing laboratory which operates in accordance to ASTIM D 3740 or E 329 and shall be acceptable to Engineer prior to engagement. Mill certificates of tests on materials made by manufacturers will be accepted provided the manufacturer maintains an adequate testing laboratory, makes regular scheduled tests, spot checked by an outside laboratory, and furnishes satisfactory certificates with name of entity making test.

B. Infiltration, line and grade of sewer, pump performance; hydrostatic test on force mains and water mains and all other tests shall be made by the Contractor with equipment qualified by Engineer and in the presence of Engineer. Engineer or Project Representative reserves the right to accept or reject testing equipment.

PART 2 – PRODUCTS

Not Used.

PART 3 – EXECUTION

3.01 PREPARATION

A. Notify Engineer in writing five days in advance of testing. Perform testing in presence of Engineer.

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B. Pressure Piping:

1. Install temporary thrust blocking or other restraint as necessary to protect adjacent piping or equipment and make taps in piping prior to testing.

2. Wait seven days minimum after concrete thrust blocking is installed to perform pressure tests. If high-early strength cement is used for thrust blocking, wait may be reduced to three days.

3. Prior to test, remove or suitably isolate appurtenant instruments or devices that could be damaged by pressure testing.

4. New Piping Connected to Existing Piping:

a. Isolate new piping with grooved-end pipe caps, spectacle blinds, blind flanges, or as acceptable to Engineer.

b. Test joint between new piping and existing piping by methods that do not place entire existing system under test load, as approved by Engineer.

5. Items that so not require testing include tank overflows, and tank atmospheric vents.

6. Test Pressure: As indicated on in each section, and other sections (min. 150 psi)

C. Test section may be filled with water and allowed to stand under low pressure prior to testing. Contractor shall pretest prior to requesting an official test.

D. Gravity Piping:

1. Perform testing after service connections, manholes, and backfilling have been completed between stations to be tested.

2. Determine groundwater level at time of testing by exploratory holes or other method acceptable to Engineer.

3.02 HYDROSTATIC TESTING FOR PRESSURE PIPING

A. Fluids: Clean water of such quality to prevent corrosion of materials in piping system.

B. Exposed Piping:

1. Perform testing on installed piping prior to application of insulation.

2. Maximum Filling Velocity: 0.25 foot per second, applied over full area of pipe.

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3. Vent piping during filling. Open vents at high points of piping system or loosen flanges, using at least four bolts, or use equipment vents to purge air pockets.

4. Maintain hydrostatic test pressure continuously for 120 minutes minimum, and for such additional time as necessary to conduct examinations for leakage.

5. Examine joints and connections for leakage.

6. Correct visible leakage and retest as specified.

7. Empty pipe of water prior to final cleaning or disinfection.

C. Buried Piping:

1. Test after backfilling has been completed.

2. Expel air from piping system during fill.

3. Apply and maintain specified test pressure with hydraulic force pump. Valve off piping system when test pressure is reached.

4. Maintain hydrostatic test pressure continuously for two hours minimum, reopening isolation valve only as necessary to restore test pressure.

5. Determine actual leakage by measuring quantity of water necessary to maintain specified test pressure for duration of test.

D. Hydrostatic and Leakage Tests – Ductile iron pipe shall be tested in accordance with AWWA Standard C 600, Section 5.2 – Hydrostatic Testing. Allowable leakage shall not exceed the formula $L = SDP^{1/2}/148{,}000$, in which L is allowable leakage in gallons per hour; S is length of pipe in feet tested; D is nominal diameter of pipe in inches; and P is average test pressure during leakage test in pounds per square inch gauge. Test shall be conducted for at least two hours and a pressure of 150 p.s.i. shall be maintained during the test. Fire lines shall be tested at 225 p.s.i. for the same duration.

E. P.V.C. pipe shall be tested in accordance with AWWA Standard C 605, Section 7.3 – Hydrostatic Testing. Allowable leakage shall not exceed formula $Q = LDP^{1/2}/148{,}000$, in which Q is allowable leakage in gallons per hour; L is length of pipe in feet tested; D is nominal diameter of the pipe in inches; and P is average test pressure during leakage test in pounds per square inch gauge. Test shall be conducted for at least two hours and a pressure of 150 p.s.i. shall be maintained during the test. Fire lines shall be tested at 225 p.s.i. for the same duration.

1. Should any test of pipe laid disclose leakage greater than the above specified, Contractor shall, at its own expense, locate and repair defective joints until leakage is within specified allowance. Contractor is responsible for notifying the Engineer 48 hours (minimum) prior to applying pressure for testing. Pressure test will be witnessed by Engineer or Project

Representative. All visible leaks shall be repaired regardless of the leakage amount.

3.03 PNEUMATIC TEST FOR PRESSURE PIPING

A. Do not perform on:

1. PVC or CPVC pipe.

2. Piping larger than 18 inches.

3. Buried and other non-exposed piping.

B. Fluid: Oil-free, dry air.

C. Procedure:

1. Apply preliminary pneumatic test pressure of 25 psig maximum to piping system prior to final leak testing, to locate visible leaks. Apply soap bubble mixture to joints and connections; examine for leakage.

2. Correct visible leaks and repeat preliminary test until visible leaks are corrected.

3. Gradually increase pressure in system to half of specified test pressure. Thereafter, increase in steps of approximately one-tenth of specified test pressure until required test pressure is reached.

4. Maintain pneumatic test pressure continuously for minimum of ten minutes and for such additional time as necessary to conduct soap bubble examination for leakage.

5. Correct visible leakage and retest as specified.

D. Allowable Leakage: Piping system, exclusive of possible localized instances at pump or valve packing, shall show no visible evidence of leakage.

E. After testing and final cleaning, purge with nitrogen those lines that will carry flammable gases to assure no explosive mixtures will be present in system during filling process.

3.04 DEFLECTION FOR GRAVITY PIPING

A. It is the Contractor's responsibility to assure backfill is sufficient to limit pipe deflection to no more than five percent. When flexible pipe is used, a deflection test shall be made by Contractor on the entire length of installed pipeline, not less than 30–days after completion of all backfill and placement of any fill. Deflection shall be determined by use of a deflection device or by use of a spherical, spheroidal, or elliptical ball, a cylinder, or circular sections fused to a common shaft. Ball, cylinder, or circular sections shall have a diameter, or minor diameter as applicable, of 95 percent of the inside pipe diameter. The ball, cylinder, or circular sections shall be of a homogeneous material throughout, shall have a

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density greater than 1.0 as related to water at 39.2 degrees Fahrenheit, and shall have a surface brinell hardness of not less than 150. The device shall be center bored and through bolted with a 1/4-inch minimum diameter steel shaft having a yield strength of 70,000 p.s.i. or more, with eyes at each end for attaching pulling cables. The eye shall be suitably backed with flange or heavy washer; a pull exerted on opposite end of shaft shall produce compression throughout remote end of ball, cylinder, or circular section. Circular sections shall be spaced so distance from the external faces of front and back sections shall equal or exceed diameter of circular section. Failure of the ball, cylinder, or circular section to pass freely through a pipe run, either by being pulled through by hand or by being flushed through with water, shall be cause for rejection of individual run. When a deflection device is used for the test in lieu of a ball, cylinder, or circular sections described, such device shall be acceptable to Engineer prior to use. Device shall be sensitive to 1.0 percent of diameter of pipe being measured and shall be accurate to 1.0 percent of indicated dimension. Installed pipe showing deflections greater than five percent of the normal diameter of pipe shall be retested by a run from opposite direction. If retest also fails, the suspect pipe shall be repaired or replaced at no cost to Owner. 100 percent of the pipe shall be tested.

3.05 LEAKAGE FOR GRAVITY PIPING

A. In no stretch of sewer between any two adjoining manholes shall infiltration/exfiltration exceed 25 gallons per day per inch of pipe diameter per mile of pipe. In case leakage exceeds this amount, the sewer shall not be accepted until such repairs and replacements are made to comply with above requirements. Such corrections will be made at the Contractor's expense. All visible leaks shall be repaired, regardless of the amount of leakage.

B. Lines shall be tested for leakage by low pressure air testing, infiltration tests, or exfiltration tests, as appropriate. Low pressure air testing for PVC pipe shall be as prescribed in ASTM F 1417. Prior to infiltration or exfiltration tests, trench shall be backfilled up to at least the lower half of pipe. If required, sufficient additional backfill shall be placed to prevent pipe movement during testing, leaving the joints uncovered to permit inspection. Visible leaks encountered shall be corrected regardless of leakage test results. When water table is two feet or more above top of pipe at upper end of pipeline section to be tested, infiltration shall be measured using a suitable weir or other device acceptable to Engineer. When Engineer determines infiltration cannot be properly tested, an exfiltration test shall be made by filling the line to be tested with water so a head of at least two feet is provided above both water table and top of pipe at upper end of pipeline to be tested. The filled line shall be allowed to stand until pipe has reached its maximum absorption, but not less than four hours. After absorption, the head shall be re–established. The amount of water required to maintain this water level during a two hour test period shall be measured. Leakage as measured by either the infiltration test or exfiltration test shall not exceed 25 gallons per inch diameter per mile of pipeline per day. When leakage exceeds the maximum amount specified, satisfactory correction shall be made and retesting accomplished. Testing, correction, and retesting shall be made at no additional cost to the Owner.

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C. The Contractor shall furnish equipment and plugs and subject force mains to hydrostatic tests at 100 p.s.i. for a period of two hours. Any leaks shall be located and repaired. Each section tested shall be slowly filled with water, care being taken to expel all air from the pipes. No pipe installation will be accepted until leakage during pressure test is less than the number of gallons listed for each 1000–feet of pipe tested:

6 inches & less – 0.9 gallons	12 inches – 1.80 gallons
8 inches – 1.20 gallons	14 inches – 2.10 gallons
10 inches – 1.50 gallons	16 inches – 2.40 gallons

100 percent of the pipe shall be tested.

3.06 DISINFECTION FOR WATER MAIN

A. After hydrostatic and leakage tests have been completed, water pipes shall be disinfected in accordance with AWWA C 651 and Regulations of the local Health Department.

B. All new mains shall be thoroughly flushed then chlorinated with not less than fifty parts per million (50 ppm) of available chlorine. Chlorine gas or 70 percent high–test calcium hypochlorite can be used. Water from existing distribution system or other source of supply should be controlled to flow slowly into the newly laid pipeline during application of chlorine. The solution shall be retained in pipeline for not less than 24 hours and a chlorine residual of 25 ppm shall be available at this time. Then system shall be flushed with potable water and the sampling program started. Prior to sampling, the chlorine residual must be reduced to normal system residual levels or be non–detectable in those systems not chlorinating. Normal system residual should be between 0.2 and 0.8 ppm. The chlorine residual shall be measured and reported. If the membrane filter method of analysis is used for coliform analysis, non–coliform growth must also be reported. If non–coliform growth is greater than eighty colonies per one hundred milliliters, the sample result is invalid and must be repeated.

C. A minimum of two samples from each sampling site shall be collected for total coliform analysis. The number of sites depends on amount of new construction, but must include all dead end lines, be representative of water in newly constructed mains, and shall be collected a minimum of every 1,200 linear feet. Each set of samples shall be taken at least 24 hours apart after disinfection and tested by a State approved lab and shall indicate bacteriological satisfactory water. Contractor shall submit results to the Engineer.

3.07 FIELD QUALITY CONTROL

A. Test Report Documentation:

1. Test date.

2. Description and identification of piping tested.

3. Test fluid.

4. Test pressure.

5. Remarks, including:

   a. Leaks (type, location).

   b. Repair/replacement performed to remedy excessive leakage.

6. Signed by Contractor and Engineer to represent that test has been satisfactory completed.

END OF SECTION

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SECTION 40 91 00

PROCESS INSTRUMENTATION

PART 1 – GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including Division 1 specification Sections, apply to this Section.

B. Additional requirements related to work specified in this Section include, but are not limited to, the following:

Section	Description
45 50 00	Membrane Bioreactor
-	Process and Instrumentation Diagrams (P&IDs)

1.02 SCOPE

A. The Contractor shall furnish and install all instrumentation and instrumentation installation hardware, conduit, and wiring necessary to provide for the complete installation of all instrumentation described in this specification. At a minimum the Contractor shall be responsible for:
1. Purchasing of all instrumentation tagged on the P&ID drawings, instrumentation schedule, or others listed in these specifications.
2. Installation and termination of all instrument and power wiring.
3. Installation and connection of all instrument pneumatic tubing and related controls.
4. Performance of instrument calibration and loop checks.

B. The Contractor shall furnish and install all necessary items and appurtenances in addition to those shown on the drawings and specified for the proper operation of the instrumentation.

C. All instrument devices where applicable shall be connected to clean dry air and electrical supply systems. The system shall be continuity checked, leak tested, ground tested, calibrated, control valves stroked, all in-line devices bolted or mounted in the proper orientation and place in the process system as a complete operable system when released by the Contractor to the Owner.

D. Calibration standards shall be traceable to the National Institute of Standards and Technology. All instruments used to verify calibration shall have superior measurement capability and be of the highest quality and accuracy.

E. All work shall be constructed true to lines and surfaces indicated in a neat, substantial, and workmanlike manner and in such a way as to properly serve the purpose intended. Equipment shall be plumb and level. All members and parts, upon installation, shall be properly supported from the building structure, existing supports, or independent support framing, secured together, and anchored in place.

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F. In cases where detailed wiring or tubing information is not included within the drawings or the accompanying specifications, the Contractor shall be responsible for installation and connecting and placing the instrument devices into proper and satisfactory service. The manufacturers' technical publications shall serve as the guidelines to incorporate these devices into the design of the system.

1.03 SUBMITTAL INFORMATION

A. In addition to any other requirements contained within the Contract Documents, provide the following:
   1. Instrumentation schedule detailing tag numbers, drawing numbers, manufacturers, model numbers, process fluid, process connection type/size, line size, power requirements, and signal type.
   2. A complete set of submittal information in PDF format. All pertinent information needed to fully describe the instrumentation and accessories shall be included in the submittal. Where multiple options are included within standard literature, project-specific part numbers and options shall be highlighted by enclosing the project-specific information (circling, clouding, text boxes) and other information shall be crossed out. Any deviations to these specifications must be listed on a separate page referencing the specification section with a brief description of the deviation and why it is equal to or superior to what is specified.

1.04 OPERATION & MAINTENANCE MANUALS

A. Operations & Maintenance manuals shall be provided prior to delivery of the instrumentation on site to support the installation of the instrumentation. The Operation & Maintenance manual in PDF form. Manuals shall include instrumentation dimensions, mounting & installation information, electrical connection information, calibration instructions, maintenance information, and a trouble shooting guide.

PART 2 – PRODUCTS

2.01 DISSOLVED OXYGEN SENSOR/TRANSMITTER

A. Sensor
   1. The sensor shall be a continuous-reading probe that utilizes luminescent sensor technology.
   2. All parts of the probe shall be corrosion resistant and fully-immersible.
   3. The measurement range shall be 0.00 to 20.00 mg/L dissolved oxygen.
   4. The operation of the analyzer shall not be affected by H2S, pH, K+1, Na+1, Mg+2, Ca+2, NH4+1, Al+3, Pb+2, Cd+2, Zn+2, Cr (total), Fe+2, Fe+3, Mn+2, Cu+2, Ni+2, Co+2, CN-1, NO3-1, SO4-2, S-2, PO4+3, Cl-1, anion active tensides, crude oils, or Cl2-1.
   5. The probe shall provide electrolyte-free operation without the requirements of sample conditioning.
   6. The sensor cap shall be warranted for one full year against defects in material and workmanship.

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7. The probe shall be warranted for three full years against defects in material and workmanship.
8. Sensor shall be self-calibrating with a response time to 90% in less than 430 seconds or to 95% in less than 60 seconds at 20 degrees C.
9. Measurement accuracy shall be approximately.1ppm below 1 ppm and approximately .2 ppm above 1 ppm.
10. The sensor shall be approved for operation from 32 to 122 degrees F.

B. Controller/Transmitter
1. The controller shall be a microprocessor-based instrument.
2. Connections between the sensors and the controller shall be "plug and play."
3. The Interface unit shall allow operators to control sensor and interface functions with menu-driven software.
4. The interface unit shall include two analog 4-20 mA outputs.
5. The interface unit shall be housed in a NEMA-4X/IP66 metal enclosure with corrosion-resistant finish.
6. The controller shall be capable of being mounted horizontally or vertically on a surface, panel, or pipe.
7. The AC power supply shall be housed in the interface unit and automatically accept input in the range of 100 to 230 VAC, 50/60 Hertz.
8. The controller shall be UL certified.
9. The controller shall be warranted for two full years against defects in material and workmanship.

C. Manufacturers
1. Hach LDO sensor with SC100 controller.
2. Approved equal.

2.02 TURBIDITY SENSOR/TRANSMITTER

A. Sensor
1. The turbidimeter shall be a microprocessor-based, continuous reading, on-line nephelometric instrument
2. The turbidimeter shall measure turbidity in the range of 0.001-100 NTU
3. Accuracy shall be approximately 2% of reading or approximately 0.015 NTU (whichever is greater) from 0 to 40 NTU; approximately 5% of reading from 40 to 100 NTU
4. Displayed resolution shall be 0.0001 NTU from 0 to 9.999 NTU and 0.001 NTU from 10.000 to 9.999 NTU.
5. Repeatability shall be better than approximately 1.0% of reading or approximately 0.002 NTU (whichever is greater).
6. The turbidimeter shall meet all design and performance criteria specified by USEPA method 180.1.
7. Light shall be directed through the surface of the sample and the detector shall be immersed in the sample, eliminating glass windows and flow cells.
8. Optical components shall be mounted in a sealed head assembly that can be removed for calibration/ service without disturbing sample flow.
9. The turbidimeter body shall be corrosion-resistant.
10. An internal bubble removal system shall be included to vent entrained air from the sample stream.

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11. Calibration of the turbidimeter shall be either formazin-based (20 or 1 NTU) or instrument comparison-based calibration method.
12. User selectable signal averaging, bubble removal, alarm and recorder output hold, and self-test diagnostics shall be provided.
13. Connections between the turbidimeter(s) and the controller shall be "plug and play."
14. The Interface unit shall allow operators to control sensor and interface functions with menu-driven software.
15. The interface unit shall include two analog outputs and 3 unpowered SPDT alarm contacts.

B. Controller/Transmitter
1. The controller shall be a microprocessor-based instrument.
2. Connections between the sensors and the controller shall be "plug and play."
3. The Interface unit shall allow operators to control sensor and interface functions with menu-driven software.
4. The interface unit shall include two analog 4-20 mA outputs.
5. The interface unit shall be housed in a NEMA-4X/IP66 metal enclosure with corrosion-resistant finish.
6. The controller shall be capable of being mounted horizontally or vertically on a surface, panel, or pipe.
7. The AC power supply shall be housed in the interface unit and automatically accept input in the range of 100 to 230 VAC, 50/60 Hertz.
8. The controller shall be UL certified.
9. The controller shall be warranted for two full years against defects in material and workmanship.

C. Manufacturers
1. Hach 1720E with SC100 controller.
2. Approved equal.

2.03 MIXED LIQUOR SUSPENDED SOLIDS (MLSS) SENSOR/TRANSMITTER

A. Sensor
1. The sensor shall use dual-beam infrared/scattered light photometer for measuring suspended solids. The LED shall transmit light at 45 degrees to the sensor face and the back-scatter photoreceptors shall detect scattered light at 140 degrees to the transmitted beam.
2. The sensor shall provide color-independent measurement.
3. The sensor shall be equipped with self-cleaning device to prevent erroneous values and maintenance problems.
4. The signal averaging time shall be user selectable ranging from 1 to 300 seconds.
5. The sensor shall be capable to measure from 0.001 mg/l to 50,000 mg/L.
6. Measurement accuracy shall be less than 5% of reading.
7. Measurement repeatability shall be less than 3% of reading.
8. The sensor shall be approved for operation from 32 F and 104 F.
9. The sensor shall be warranted for one full year.
10. The sensor shall be enclosed in stainless steel or PVC and shall include a silicon wiper blade and integral cable.

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B. Controller
1. The controller shall be a microprocessor-based instrument.
2. Connections between the sensors and the controller shall be "plug and play."
3. The Interface unit shall allow operators to control sensor and interface functions with menu-driven software.
4. The interface unit shall include two analog 4-20 mA outputs.
5. The interface unit shall be housed in a NEMA-4X/IP66 metal enclosure with corrosion-resistant finish.
6. The controller shall be capable of being mounted horizontally or vertically on a surface, panel, or pipe.
7. The AC power supply shall be housed in the interface unit and automatically accept input in the range of 100 to 230 VAC, 50/60 Hertz.
8. The controller shall be UL certified.
9. The controller shall be warranted for two full years against defects in material and workmanship.

C. Manufacturers
1. HACH SOLITAX with SC100 controller.
2. Approved Equal.

2.04 pH SENSOR/TRANSMITTER

A. Sensor
1. The pH sensor shall be of differential electrode technique design using two measuring electrodes to compare the process value to a stable internal reference standard buffer solution. The standard electrode shall have non-flowing and fouling resistant characteristics.
2. The pH sensor shall have a built-in preamplifier to enable the signal to be transmitted up to 100 meters (328 feet) with standard cabling and up to 1000 meters (3280 feet) with a termination box.
3. The pH sensor shall have NTC 300 ohm thermistor for automatic temperature compensation and shall have a analyzer temperature readout.
4. The measurement range shall be -2 to 14 pH.
5. The measurement sensitivity shall be approximately 0.01pH.
6. The sensor shall be suitable for operation from 23 F to 158 F.
7. The sensor material shall be PEEK®, salt bridge of matching material with Kynar® junction, glass process electrode, titanium ground electrode, and Viton® O-ring seals.

B. Controller
1. The controller shall be a microprocessor-based instrument.
2. Connections between the sensors and the controller shall be "plug and play."
3. The Interface unit shall allow operators to control sensor and interface functions with menu-driven software.
4. The interface unit shall include two analog 4-20 mA outputs.
5. The interface unit shall be housed in a NEMA-4X/IP66 metal enclosure with corrosion-resistant finish.
6. The controller shall be capable of being mounted horizontally or vertically on a surface, panel, or pipe.

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7. The AC power supply shall be housed in the interface unit and automatically accept input in the range of 100 to 230 VAC, 50/60 Hertz.
8. The controller shall be UL certified.
9. The controller shall be warranted for two full years against defects in material and workmanship.

C. Manufacturers
1. HACH Differential pH with SC100 controller.
2. Approved equal.

2.05 HYDROSTATIC LEVEL TRANSMITTER

A. The level transmitter shall be a hydrostatic pressure sensor with an integral baffle plate to protect the sensing element from debris.

B. The level transmitter shall measure up to 23 feet of water head.

C. The level transmitter shall have a static accuracy of 0.5% FSO BFSL and one year stability of 0.20% FSO.

D. The response time shall be less than 5 ms.

E. The signal output shall be 4-20 mA DC two wire twisted pair grounded shield cable at 0.042 ohm per foot.

F. The transmitter shall be approved for operation from -20 F to 190 F.

G. The transmitter and sensor shall be made of 316 stainless steel. The cable shall be polyurethane-jacketed cable with 40 feet of length.

H. The transmitter shall require 10-30 VDC unregulated power.

I. Manufacturers
1. Blue Ribbon Bird Cage Level Transmitter.
2. Endress and Hauser FMX Level Transmitter.
3. Approved equal.

2.06 ULTRASONIC LEVEL TRANMITTER

A. The transmitter shall use the Sonic Intelligence® echo processing technology.

B. The measuring range shall be 0.8 feet to 26 feet.

C. The accuracy shall be 0.25% of measuring range (in air).

D. The transmitter shall be suitable for operation under ambient temperature conditions from -40 F to 140 F and shall include built-in temperature compensation.

E. The Power supply required for the transmitter shall be 12 to 28 V DC, max 0.1 A. The max power consumption shall be 0.75 W (25 mA at 24 V DC).

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F. The output signal shall be 4-20mA and max load shall be 600Ω in the loop at 24 V DC.

G. The transmitter shall have CE, CSA NRTL/C, FM and 3A certificates, and approvals.

H. The transmitter electronics enclosure shall be made of PVC and transducer shall be made of PVDF copolymer.

I. Manufacturers
   1. Siemens Milltronics Level Transmitter.
   2. Approved equal.

2.07 LEVEL SWITCH

A. The level switch shall be an enclosed, narrow angle, mechanical float switch designed for use in sewage environments.

B. The level switch shall utilize mechanically-activate microswitches for indication of specific water levels. Level switches containing mercury shall not be acceptable.

C. The switches shall be a single-pole, double throw (SPDT) type and have an electrical rating of 10 amps at 120 VAC.

D. The power cord shall be chlorinated polyethylene type SJ00W-300 volt on 16/3.

E. The float shall be ABS or polypropylene material and shall be leak proof, shock proof, and impact resistant.

F. The level switches shall be supplied with an anchor to which the float shall be tethered. The anchor shall allow for adjustment of the actuation level and be of sufficient weight as to hold the floats secure in a well-mixed tank. The anchor shall be constructed of corrosion-resistant material suitable for continuous submergence in mixed liquor.

G. Manufacturers
   1. Conery 2902 Series Mechanical Angle float switches.
   2. Kobold NAE Series float switches.

2.08 TEMPERATURE SWITCH

A. The enclosure material shall be Die cast aluminum, epoxy powder coated, gasketed, and with captive cover screws.

B. The enclosure shall meet NEMA 4X requirements.

C. The set point repeatability shall be within approximately1% of adjustable temperature range.

D. The output shall be SPDT snap action switch.

E. The switch shall be electrically rated for 20A 125/250/480 VAC resistive.

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F. The temperature dead band shall be within 2% of range under laboratory conditions (70 F ambient circulating bath at rate of ½ F per minute change).

G. The immersion stem shall be made of nickel-plated brass.

H. Manufacturers
   1. United Electric.
   2. Approved equal.

2.09 TEMPERATURE GAUGE

A. The temperature gauge shall be hermetically sealed to prevent moisture entry into the casing.

B. The temperature gauge shall be tamperproof with Maxivision dial for accurate temperature readings.

C. The temperature gauge shall be suitable for use in ambient temperature between -40 F and 200 F.

D. The temperature gauge shall measure temperature from 50 F to 400 F.

E. The temperature gauge accuracy shall be 1% full span to ASME B40.3 (Grade A).

F. The bimetal coils used are heat treated for optimum stability and over temperature capability.

G. The temperature gauge case and stem material shall be 304 SS.

H. Manufacturers
   1. Ashcroft Bimetal Thermometers.
   2. Approved equal.

2.10 FLOW SENSOR/TRANSMITTER FOR PERMEATE AND MIXED LIQUOR SERVICE

A. The flow meter shall be a magnetic flow meter which shall utilize bipolar pulse DC coil excitation to measure voltage induced by flow through a magnetic flux.

B. The voltage shall be linearly proportional to flow velocity from 0.033 to 33 feet per second. Standard accuracy of the pulse output between one and 33 feet per second shall be approximately 0.5% of rate approximately 0.02% of full scale (33 feet per see) for all meters.

C. The flow meters shall consist of a flanged metering tube and an integrally-mounted transmitter.

D. The flow metering system shall be microprocessor based and both the sensor and transmitter shall have chips to store and process data. The electronics shall be interchangeable for meters from ½-inch to 78 inches.

E. The tube shall be lined with polyurethane and shall have ISO standard flange to flange lay lengths. Unless noted otherwise in the instrument schedule, the flanges

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shall be ANSI B16.1 Class 150 for 12 inches and smaller and AWWA Class D for 14 inches and larger.

F. There shall be two measuring electrodes, a grounding electrode, and one for empty pipe detection. The electrodes shall be the bullet-nosed type of 316SS material. The electrode circuit shall have a minimum impedance of 10^{12} ohms to overcome moderate coating buildup.

G. The power supply to the transmitter shall be 85 - 260 VAC. Transmitter housing shall be powder coated cast aluminum with NEMA 4X rating.

H. A 2-line x 16 character backlight LCD shall simultaneously display flow rate and total flow in user-selectable engineering units.

I. An integrated AUTO-ZERO function shall compensate for any external interference and eliminate zero-drift. An AUTOGAIN function shall enable a 1000:1 turndown measuring range by amplifying the measuring signal and increasing measurement resolution at various flow rates. To further ensure the specified accuracy, the electronics shall automatically perform an internal temperature drift compensation.

J. Upon any power failure, the unit shall retain all setup parameters and accumulated measurements internally in non-volatile memory. All units shall be protected against voltage spikes from the power source with internal transient protection. Power consumption shall be no more than 16 VA, independent of meter size.

K. The transmitter shall output a 4-20 mA DC directly proportional to flow rate plus a scaled 24 VDC pulse or open collector frequency output. The analog output shall have an adjustable response time from 0.06 to 100 seconds and shall include an infinitely adjustable low flow cutoff.

L. The meters shall be calibrated in a flow facility that is monitored by a globally acceptable monitoring agency such as NIST. Each meter shall ship with a certificate of a 3-point calibration report exceeding stated accuracy of 0.5%.

M. The manufacturer shall warranty the meters for manufacturing defects for a period of 18 months after shipment or 12 months after startup.

N. Manufacturers
   1. Endress & Hauser Model 50W.
   2. Approved equal.

2.11 FLOW SENSOR/TRANSMITTER FOR CLEAN-IN-PLACE CHEMICAL SERVICE

A. The flow meter shall be a magnetic flow meter which shall utilize bipolar pulse DC coil excitation to measure voltage induced by flow through a magnetic flux.

B. The voltage shall be linearly proportional to flow velocity from 0.033 to 33 feet per second. Standard accuracy of the pulse output between one and 33 feet per second shall be approximately 0.5% of rate approximately 0.02% of full scale (33 feet per see) for all meters.

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C. The flow meters shall consist of a flanged metering tube and an integrally-mounted transmitter.

D. The flow metering system shall be microprocessor based and both the sensor and transmitter shall have chips to store and process data. The electronics shall be interchangeable for meters from 1 inch -12 inches.

E. The tube shall be lined with PTFE and shall have ISO standard flange to flange lay lengths. Unless noted otherwise in the instrument schedule, the flanges shall be ANSI B16.1 Class 150 for 12 inches.

F. There shall be two measuring electrodes, a grounding electrode, and one for empty pipe detection. The electrodes shall be the bullet-nosed type of Alloy C-22 material. The electrode circuit shall have a minimum impedance of 10^{12} ohms to overcome moderate coating buildup.

G. The transmitter shall be a three stage microprocessor controller mounted integrally or remotely as specified in the instrument schedule. The power supply to the transmitter shall be 85 - 260 VAC. Transmitter housing shall be powder coated cast aluminum with NEMA 4X rating.

H. A 2-line x 16 character backlight LCD shall simultaneously display flow rate and total flow in user-selectable engineering units. The display shall be used in conjunction with integral push buttons for configuration and diagnostic messages.

I. An integrated AUTO-ZERO function shall compensate for any external interference and eliminate zero-drift. An AUTOGAIN function shall enable a 1000:1 turndown measuring range by amplifying the measuring signal and increasing measurement resolution at various flow rates. To further ensure the specified accuracy, the electronics shall automatically perform an internal temperature drift compensation.

J. Upon any power failure, the unit shall retain all setup parameters and accumulated measurements internally in non-volatile memory. All units shall be protected against voltage spikes from the power source with internal transient protection. Power consumption shall be no more than 16 VA, independent of meter size.

K. The transmitter shall output a 4-20 mA DC directly proportional to flow rate plus a scaled 24 VDC pulse or open collector frequency output. The analog output shall have an adjustable response time from 0.06 to 100 seconds and shall include an infinitely adjustable low flow cutoff.

L. The meters shall be calibrated in a flow facility that is monitored by a globally acceptable monitoring agency such as NIST. Each meter shall ship with a certificate of a 3-point calibration report exceeding stated accuracy of 0.5%.

M. The manufacturer shall warranty the meters for manufacturing defects for a period of 18 months after shipment or 12 months after startup.

N. Manufacturers
   1. Endress & Hauser Model 50P.

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2. Approved equal.

2.12 ROTAMETER (LIQUID SERVICE)

A. The liquid rotameter shall be a variable-area style flow meter.

B. The rotameter shall be rated for service up to 145 psig and temperatures up to 140 degree F with an accuracy of approximately 4% of full scale.

C. The rotameter shall have a polysulfone measuring tube with a direct reading scale which is calibrated for measurement in gallons per minute.

D. The rotameter shall be supplied with PVC socket x half union connections.

E. The float shall be PVDF.

F. The rotameter shall be supplied with EPDM o-rings.

G. Manufacturers
1. Kobold KSM series
2. Approved equal.

2.13 FLOW SENSOR/TRANSMITTER FOR AIR SERVICE

A. The flow meters shall be an insertion-style with an integrally-mounted transmitter.

B. The voltage shall be linearly proportional to flow velocity from 0.65 to 275 feet per second. Standard accuracy of the pulse output between .65 and 275 feet per second shall be approximately 1.5% of reading approximately 0.5% of full scale (275 Feet Per Second) for all meters. The installation location shall meet the manufactures installation guidelines for straight run requirements with and without using a flow conditioner.

C. The air flow metering system shall be microprocessor based and both the sensor and transmitter shall have chips to store and process data. The electronics shall be interchangeable for meters from 3 inches to 60 inches.

D. The metering mechanism shall be manufactured of 316 Stainless steel sensors shall be of the proper sizes to measure the design flow rate of the piping and shall be noted in the instrument schedule.

E. Repeatability .5% for velocities above .65 feet per second.

F. The transmitter shall be a three stage microprocessor controller mounted integrally or remotely as specified in the instrument schedule. The power supply to the transmitter shall be 85 - 260 VAC, 45 to 65 Hertz. or 20 to 55 V AC, 45 to 65 Hertz, or 16 to 62 V DC transmitter housing shall be powder coated cast aluminum with NEMA 4X rating.

G. Upon any power failure, the unit shall retain all setup parameters and accumulated measurements internally in non-volatile memory. All units shall be protected against voltage spikes from the power source with internal transient

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protection. Power consumption shall be no more than 16 VA, independent of meter size.

H. The transmitter shall output a 4-20 mA DC directly proportional to flow rate plus a scaled 24 VDC pulse or open collector frequency output. The analog output shall have an adjustable response time from 0.06 to 100 seconds and shall include an infinitely adjustable low flow cutoff.

I. Each meter shall be provided with a certificate of a 3-point calibration report exceeding stated accuracy of 1.5% of reading for 100% to 20% of full scale at reference conditions, .3% of full scale for 20% to 1% of full scale at reference conditions.

J. Manufacturer
1. Endress Hauser Model 65I.
2. Sierra Model 640S.
3. Approved equal.

2.14 ROTAMETER (AIR SERVICE)

A. The air flow rotameter shall be a glass tube variable-area style flow meter.

B. The rotameter shall be rated for service up to 100 psig and temperatures up to 212 degree F with an accuracy of approximately - 1% of full scale.

C. The air flow rotameter shall have a tempered glass measuring tube with a direct reading scale which is calibrated for measurement of air in SCFH.

D. The rotameter shall be supplied with 316 stainless steel 150 lb ANSI flanges.

E. The float shall be 316 stainless steel

F. The rotameter shall be supplied with EPDM orings.

G. Manufacturers
1. Kobold KDV series.
2. Approved equal.

2.15 PRESSURE SENSOR/TRANSMITTER FOR LIQUID SERVICE

A. The pressure transmitter shall be a loop-powered, two-wire device requiring a 11-30 VDC power input with a 4-20 mA DC output, superimposed on the power input lines, proportional to the calibrated span. The sensor shall have a plus 5% zero point adjustment with no on site calibration required.

B. The transmitter shall be housed in a compact 304SS enclosure and shall be designed and constructed to allow for direct mechanical mounting by the process connection, requiring no additional mounting hardware. The enclosure shall be NEMA4X.

C. The transmitter shall utilize capacitance technology in conjunction with a dry cell (no oil fill) ceramic diaphragm design for pressures up to 500 PSIG/A. Maximum

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deflection of the ceramic diaphragm shall not exceed 0.001 inch full scale movement to minimize diaphragm fatigue and the effects of build-up. The ceramic diaphragm shall be immune to damage due to vacuum and shall have an overpressure (proof) pressure rating of at least 150 PSI.

D. The accuracy shall be approximately 0.5 % of full span including hysteresis and repeatability. The change of zero point between -4…+185 degrees F shall be no more than 1.5%. Long term stability shall not exceed a 0.15% shift per year.

E. Manufacturers
   1. Endress+Hauser PMC131.
   2. Approved equal.

2.16 PRESSURE SENSOR/TRANMITTER (AIR SERVICE)

A. The pressure transmitter shall be a loop-powered, two-wire device requiring a 11-30 VDC power input with a 4-20 mA DC output, superimposed on the power input lines, proportional to the calibrated span. The sensor shall have a plus 5% zero point adjustment with no on site calibration required.

B. The transmitter shall be housed in a compact 304SS enclosure and shall be designed and constructed to allow for direct mechanical mounting by the process connection, requiring no additional mounting hardware. The enclosure shall be NEMA4X.

C. The transmitter shall utilize capacitance technology in conjunction with a dry cell (no oil fill) ceramic diaphragm design for pressures up to 500 PSIG/A. Maximum deflection of the ceramic diaphragm shall not exceed 0.001 inch full scale movement to minimize diaphragm fatigue and the effects of build-up. The ceramic diaphragm shall be immune to damage due to vacuum and shall have an overpressure (proof) pressure rating of at least 150 PSI.

D. The accuracy shall be approximately 0.5 % of full span including hysteresis and repeatability. The change of zero point between -4…+185 degrees F shall be no more than 1.5%. Long term stability shall not exceed a 0.15% shift per year.

E. Manufacturers
   1. Endress+Hauser PMC131.
   2. Approved equal.

2.17 PRESSURE SWITCH

A. The pressure switch shall feature diaphragm sensing technology, a 20 amp snap-acting switch, and adjustable pressure ranges up to 475 psi.

B. The pressure switch should be able to operate in 0 to 160 F (17 to 71 C). Set point shifts less than 1% of range for a 50 F (28 C) ambient temperature change.

C. The pressure switch shall use an EPDM sensor material and should handle a maximum temperature of 250 degrees F.

D. The pressure switch shall be enclosed in Type 1 Enclosure and shall be made of Zinc plated steel with bright chromate finish.

E. The pressure switch should be surface mounted with two screws through clearance holes, or mounted by pressure connection.

F. The pressure switch shall have electrical rating of 20 A at 480 VAC

G. Manufacturers
   1. United electric 25 Series Model 25A1F4A pressure switch.
   2. Approved equal.

2.18 PRESSURE GAUGE

A. The pressure shall be solid front and hinged blow-out back style with elastomer compensating diaphragm on the inside of the hinged blow-out back.

B. The pressure gauge accuracy shall be 0.5% full scale to ASME B40.1 standard (Grade 2A)

C. The pressure gauge case and blow-out back shall be made of molded fiberglass reinforced thermoplastic and should be fire retardant and impact resistant

D. The pressure gauge lens shall be 4 mm thick laminated safety glass with lens rind made of molded fiberglass reinforced thermoplastic.

E. The fillable liquid used for the pressure gauge shall be glycerin.

F. The Stem and socket connections shall be made of 316 Stainless steel.

G. Manufacturers
   1. McDaniel MPB-S Pressure gauge.
   2. Approved equal.

PART 3 – EXECUTION

3.01 GENERAL

A. All material and equipment shall be installed in accordance with manufacturer's technical instructions, engineering drawings and as may be required by the applicable codes of the state and city. Drawings do not attempt to show exact details of all routing, and no extra payment will be allowed for obstruction by work of other trades or local obstructions to the work under this Contract that require offsets. Piping drawings shall be used as dimensioned and indicated for proper process taps to all instruments.

B. The Contractor shall be responsible for identifying interferences and submitting in writing to the Owner's Representative changes required to resolve interferences.

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3.02 IDENTIFICATION PLATES AND CODING

A. All components provided under this section, both field and rack mounted, shall be provided with permanently mounted name tags bearing the entire ISA tag number of the component. Rack mounted tags shall be plastic; field mounted tags shall be stamped stainless steel.

B. The Contractor shall attach nametags to control devices with screws, bolts, or wire leader to create a permanent bond.

3.03 WIRING INSTALLATION

A. Wiring shall be installed in a neat manner and exhibit no skinned insulation. Bends in cables and wiring shall not be less than manufacturers' recommended radius.

B. Connections at the instrument and terminal strips shall adhere to the strictest standards of quality terminations. Splices shall not be allowed except where instruments have pigtails. There the wire shall be scotch locked and taped to prevent moisture entering under the cap. High grade electrical tape shall be used. In all practical installation, terminations in junction boxes at terminal strips shall be provided.

3.04 INSTRUMENT INSTALLATION REQUIREMENTS

A. The Contractor shall install instrument devices in accordance with appropriate installation procedures to insure the manufacturers' published accuracy of the devices.

B. Extreme caution should be observed to install in-line measuring devices in the proper orientation. Manufacturer's installation procedures for placing the instrument in service shall be adhered to. Body ends and seats shall be installed facing the proper directions to insure no leakage occurs past the seat.

C. Gasket material as defined by the piping specifications shall be installed with the appropriate valves. Proper tightening of flange bolts to prevent uneven gasket loading shall be checked by the Contractor.

D. All instruments shall be installed in accordance with the location drawings and technical specifications guidelines. All instruments shall be accessible from grade, platforms, ladders or catwalks. All locally mounted indicating transmitters and gages shall be faced toward the normal operating aisle and be within reading capability from normal line of site.

E. Brackets shown for attachment to walls columns, masonry or structural steel shall be installed so as not to obstruct any access or regress from any approach.

F. Instruments shall be grouped where practical and be mounted in locations so as not to block motors or equipment required to be pulled for maintenance or check out.

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G. Instruments shall be mounted level and plumb, rigidly supported in a manner disallowing transmission of vibration to adjoining structures, components, walls or cabinets. Freedom from interference of piping and electrical conduit shall be required. Services brought to the instruments shall not prevent the installation or removal for maintenance purposes. Process tubing routed to the instrument shall not block access to the instrument.

H. All instrument devices shall be calibrated, bench tested and verified ranges shall be recorded and checked against the specification sheet prior to installation in the field.

3.05 INSTRUMENT PROCESS CONNECTIONS

A. The Contractor shall complete all necessary connections to process equipment, control panels, and instruments as required to meet the intent of the drawings. All vents and drains from instrument process piping shall be routed to the proper vent headers or sewers as required for environmental reasons or as provided for in the job specifications and drawings.

B. Over range limit, maximum working pressure and static pressure limits shall not be exceeded to prevent damage to the transmitter. The Manufacturer shall specify all transmitters and measuring elements to be compatible with the pressure and temperature ranges of process parameters.

C. Process temperature limit, ambient temperature limit and storage temperature limit shall not be exceeded in any installation. The Manufacturer shall ensure the installation provides affordable protection to the instrument devices.

3.06 INSTRUMENT SETUP/PROGRAMMING

A. The contractor shall setup and program all instrumentation. As necessary, the Contractor shall have the Manufacturer's Representative on-site to program or setup any instrumentation, and ensure that no warranties are voided.

B. Copies of all software, programs, or equipment setup logs shall be given to the Owner prior to completion of the project. This information shall be made available to the Owner or Owner's Representative upon request at any time during construction or check-out of equipment.

3.07 INSTRUMENT CALIBRATION

A. The Contractor shall calibrate all instrumentation in a suitable environment to quality testing procedures. High accuracy comparative instruments or mechanisms shall be the standard against which instrument calibration is tested.

B. Simulated operating conditions for individual instruments and operating as a complete loop or system shall be calibrated to ensure control accuracy.

C. Manufacturer's installation and calibration literature shall be kept in the same file and turned over to the owner at the end of commissioning the instruments.

D. Record keeping shall include all original calibration curves supplied and certified by the factory. Any additional maintenance literature shipped with the instrument shall be kept on record.

E. The Contractor shall not energize nor pressurize systems until the installations have been approved by the Owner.

3.08 FIELD QUALITY CONTROL

A. Contractor is to inspect the installed instrumentation for visual deficiencies

B. Prior to acceptance by owner, an operational test of all instruments and control systems shall be conducted to determine if the installed instruments meet the purpose and intent of the specifications. Tests shall demonstrate that all equipment is electrically, mechanically, structurally, and otherwise acceptable; it is safe and in optimum working condition; and conforms to the specified operating characteristics.

3.09 PROTECTION

A. The contractor shall be responsible for provisions to protect the instrumentation after installation but prior to acceptance by the Owner. Protection of the instrumentation shall include provisions during installation and testing of nearby piping, valving, or other adjacent equipment. The Contractor shall remove all protective measures installed at completion and acceptance of the project.

END OF SECTION

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SECTION 40 91 16.29

MAGNETIC FLOW METERS

PART 1 - GENERAL

1.1 THE REQUIREMENT

A. The Contractor shall furnish, test, install and place in satisfactory operation the magnetic flow meters, with all hardware, conduit, wiring, spare parts, accessories, and appurtenances as herein specified, as recommended by the manufacturers and as shown on the Drawings necessary to complete installation.

B. The Contractor shall furnish and install all necessary items and appurtenances in addition to those shown on the drawings and specified for the proper operation of the instrumentation.

C. All instrument devices where applicable shall be connected to clean dry air and electrical supply systems. The system shall be continuity checked, leak tested, ground tested, calibrated, control valves stroked, all in-line devices bolted or mounted in the proper orientation and place in the process system as a complete operable system when released by the Contractor to the Owner.

D. Calibration standards shall be traceable to the National Institute of Standards and Technology. All instruments used to verify calibration shall have superior measurement capability and be of the highest quality and accuracy.

E. All work shall be constructed true to lines and surfaces indicated in a neat, substantial, and workmanlike manner and in such a way as to properly serve the purpose intended. Equipment shall be plumb and level. All members and parts, upon installation, shall be properly supported from the building structure, existing supports or independent support framing, secured together, and anchored in place.

F. In cases where detailed wiring or tubing information is not included within the drawings or the accompanying specifications, the Contractor shall be responsible for installation and connecting and placing the instrument devices into proper and satisfactory service. The manufacturers' technical publications shall serve as the guidelines to incorporate these devices into the design of the system.

G. Coordinate signal requirements with MBR System Supplier.

1.2 RELATED WORK SPECIFIED ELSEWHERE

A. Section 40 91 00 Process Instrumentals

B. Section 45 50 00 Membrane Bioreactor (MBR) System

1.3 SUBMITTAL INFORMATION

A. In addition to any other requirements contained within the Contract Documents, provide the following:

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1. Instrumentation schedule detailing tag numbers, drawing numbers, manufacturers, model numbers, process fluid, process connection type/size, line size, power requirements, and signal type.

2. A complete set of submittal information in PDF and MSWord format. All pertinent information needed to fully describe the instrumentation and accessories shall be included in the submittal. Where multiple options are included within standard literature, project-specific part numbers and options shall be highlighted by enclosing the project-specific information (circling, clouding, text boxes) and other information shall be crossed out. Any deviations to these specifications must be listed on a separate page referencing the specification section with a brief description of the deviation and why it is equal to or superior to what is specified.

1.4 OPERATION & MAINTENANCE MANUALS

A. Operations & Maintenance manuals shall be provided prior to delivery of the instrumentation on site to support the installation of the instrumentation. The Operation & Maintenance manual in PDF form. Manuals shall include instrumentation dimensions, mounting and installation information, electrical connection information, calibration instructions, maintenance information, and a trouble shooting guide.

PART 2 - PRODUCTS

2.1 MAGNETIC FLOW METER SYSTEMS

A. Magnetic flow meter systems shall include a magnetic flow tube and a microprocessor-based "smart" transmitter that is capable of converting and transmitting a signal from the flow tube. Magnetic flow meters shall utilize the characterized field principle of electromagnetic induction, and shall produce DC signals directly proportional to the liquid flow rate.

B. Each meter shall be furnished with a stainless steel metering tube and carbon steel flanges with a polyurethane, ceramic, neoprene, or Teflon liner as required by the application and/or as specified herein. Liner shall have a minimum thickness of 0.125 inches. The inside diameter of the liner shall be within 0.125 inches of the inside diameter of the adjoining pipe. Liner protectors shall be provided on all flow tubes.

C. The flow tube shall be provided with flush mounted electrodes. Ultrasonic electrode cleaning shall not be acceptable.

D. Grounding rings shall be provided for all meters.

E. All materials of construction for metallic wetted parts (electrodes, grounding rings, etc.) shall be minimum 316 stainless steel, but shall be compatible with the process fluid for each meter in accordance with the recommendations of the manufacturer.

F. Flow tube shall be rated for pressures up to 1.1 times the flange rating of adjacent piping. System shall be rated for ambient temperatures of -30 to +65□C. Meter and transmitter housings shall meet NEMA 4X requirements as a minimum. When meter and transmitter are located in classified explosion hazard areas, the meter and

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transmitter housings shall be selected with rating to meet the requirements for use in those areas. Non-metallic transmitter housings shall not be acceptable.

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

H. The transmitter's preamplifier input impedance shall be a minimum of 10^9-10^{11} ohms which shall make the system suited for the amplification of low-level input signals and capable of operation with a material build up on the electrodes.

I. The transmitter shall provide an automatic low flow cutoff below a user configurable low flow condition (0-10%). The transmitter's outputs shall also be capable of being forced to zero by an external contact operation.

J. Each flow tube shall be factory calibrated and assigned a calibration constant or factor to be entered into the associated transmitter as part of the meter configuration parameters. Manual calibration of the flow meter shall not be required. Meter configuration parameters shall be stored in non-volatile memory in the transmitter. An output hold feature shall be provided to maintain a constant output during configuration changes.

K. The transmitter shall be capable of communicating digitally with a remote configuration device via a frequency-shift-keyed, high frequency signal superimposed on the 4-20 mA output signal. The remote configuration device shall be capable of being placed anywhere in the 4-20 mA output loop. A password-based security lockout feature shall be provided to prevent unauthorized modification of configuration parameters.

L. Accuracy shall be 0.5 percent of rate over the flow velocity range of 1.0 to 30.0 feet per second. Repeatability shall be 0.1 percent of rate; minimum turndown shall be 100:1. Minimum required liquid conductivity shall not be greater than five uS/cm. Maximum response time shall be adjustable between 1 and 100 seconds as a minimum. Transmitter ambient temperature operating limits shall be -10 to +50°Celcius. Power supply shall be 115 VAC, 60 Hertzz.

M. Flow tubes shall be 150-pound flange mounted unless otherwise noted. The cables for interconnecting the meter and transmitter shall be furnished by the manufacturer. Transmitter shall be mounted integrally on flow tube, wall, or two-inch pipe mounted as shown in the Drawings or as specified.

N. Magnetic flow meter systems shall be as manufactured by Rosemount or approved equivalent.

PART 3 - EXECUTION

3.1 REQUIREMENTS

A. Ground magnetic flow meter flow tubes and grounding rings in strict accordance with the manufacturer's recommendations.

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B. Refer to the specifications for further requirements.

3.2 GENERAL

A. All material and equipment shall be installed in accordance with manufacturer's technical instructions, engineering drawings and as may be required by the applicable codes of the state and city. Drawings do not attempt to show exact details of all routing, and no extra payment will be allowed for obstruction by work of other trades or local obstructions to the work under this Contract that require offsets. Piping drawings shall be used as dimensioned and indicated for proper process taps to all instruments.

B. The Contractor shall be responsible for identifying interferences and submitting in writing to the Owner and Engineer changes required to resolve interferences.

3.3 WIRING INSTALLATION

A. Wiring shall be installed in a neat manner and exhibit no skinned insulation. Bends in cables and wiring shall not be less than manufacturers' recommended radius.

B. Connections at the instrument and terminal strips shall adhere to the strictest standards of quality terminations. Splices shall not be allowed except where instruments have pigtails. There the wire shall be scotch locked and taped to prevent moisture entering under the cap. High grade electrical tape shall be used. In all practical installation, terminations in junction boxes at terminal strips shall be provided.

3.4 INSTRUMENT INSTALLATION REQUIREMENTS

A. The Contractor shall install instrument devices in accordance with appropriate installation procedures to insure the manufacturers' published accuracy of the devices.

B. Extreme caution should be observed to install in-line measuring devices in the proper orientation. Manufacturer's installation procedures for placing the instrument in service shall be adhered to. Body ends and seats shall be installed facing the proper directions to insure no leakage occurs past the seat.

C. Gasket material as defined by the piping specifications shall be installed with the appropriate valves. Proper tightening of flange bolts to prevent uneven gasket loading shall be checked by the Contractor.

D. All instruments shall be installed in accordance with the location drawings and technical specifications guidelines. All instruments shall be accessible from grade, platforms, ladders or catwalks. All locally mounted indicating transmitters and gages shall be faced toward the normal operating aisle and be within reading capability from normal line of site.

E. Brackets shown for attachment to walls columns, masonry or structural steel shall be installed so as not to obstruct any access or regress from any approach.

F. Instruments shall be grouped where practical and be mounted in locations so as not to block motors or equipment required to be pulled for maintenance or check out.

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G. Instruments shall be mounted level and plumb, rigidly supported in a manner disallowing transmission of vibration to adjoining structures, components, walls or cabinets. Freedom from interference of piping and electrical conduit shall be required. Services brought to the instruments shall not prevent the installation or removal for maintenance purposes. Process tubing routed to the instrument shall not block access to the instrument.

H. All instrument devices shall be calibrated, bench tested and verified ranges shall be recorded and checked against the specification sheet prior to installation in the field.

3.5 INSTRUMENT CALIBRATION

A. The Contractor shall calibrate all instrumentation in a suitable environment to quality testing procedures. High accuracy comparative instruments or mechanisms shall be the standard against which instrument calibration is tested.

B. Simulated operating conditions for individual instruments and operating as a complete loop or system shall be calibrated to ensure control accuracy.

C. Manufacturer's installation and calibration literature shall be kept in the same file and turned over to the owner at the end of commissioning the instruments.

D. Record keeping shall include all original calibration curves supplied and certified by the factory. Any additional maintenance literature shipped with the instrument shall be kept on record.

E. The Contractor shall not energize nor pressurize systems until the installations have been approved by the Owner.

3.6 FIELD QUALITY CONTROL

A. Contractor is to inspect the installed instrumentation for visual deficiencies.

B. Prior to acceptance by owner, an operational test of all instruments and control systems shall be conducted to determine if the installed instruments meet the purpose and intent of the specifications. Tests shall demonstrate that all equipment is electrically, mechanically, structurally, and otherwise acceptable; it is safe and in optimum working condition; and conforms to the specified operating characteristics.

3.7 PROTECTION

A. The contractor shall be responsible for provisions to protect the instrumentation after installation but prior to acceptance by the Owner. Protection of the instrumentation shall include provisions during installation and testing of nearby piping, valving, or other adjacent equipment. The Contractor shall remove all protective measures installed at completion and acceptance of the project.

END OF SECTION

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SECTION 40 95 13

MBR CONTROL PANEL

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SECTION 40 95 13

MBR CONTROL PANEL

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

B. Additional requirements related to work specified in this Section include, but are not limited to, the following.

Section	Description
45 50 00	Membrane Bioreactor
40 95 20	MBR SCADA Hardware and Software

1.02 REFERENCES

A. Standards referenced in this section are listed below:

1. National Electrical Code (NEC): NFPA 70.

2. National Electrical Manufacturer's Association (NEMA):

   a. NEMA 250 - Enclosures for Electrical Equipment (1,000 Volt Maximum).

   b. NEMA ICS 6 - Enclosures for Industrial Control and Systems.

3. Underwriters Laboratories Inc. (UL):

   a. UL 50 - Enclosures for Electrical Equipment.

   b. UL 508 - Industrial Control Equipment.

   c. UL 508A - Standard for Industrial Control Panels.

1.03 SCOPE

A. This Section specifies the hardware requirements for the MBR control panel.

B. The control panel, as specified herein, shall be furnished by the same System Integrator as outlined in 40 95 20 MBR SCADA Software and Hardware.

C. The control panel provider shall be responsible for the following:

   A. Design of the MBR system control panel.

B. Development of the MBR system control panel submittal documentation and drawing set.

C. Fabrication of the MBR system control panel.

D. Delivery of the MBR system control panel in packaging designed to prevent physical damage.

1.04 QUALITY ASSURANCE

A. Assemble panels, enclosures, and rack systems along with all internal and external devices, wiring, equipment, and materials in a facility that is recognized by Underwriters Laboratories to assemble and certify UL-labeled control panels:

1. All components and equipment shall comply with requirements to meet UL508 listing.

2. All control panels shall be UL 508A labeled unless otherwise allowed for in the Contract Documents.

1.05 SUBMITTAL INFORMATION

A. Provide a complete set of submittal information in PDF format. All pertinent information shall fully describe the hardware, software, and accessories included in the submittal. Where multiple options are included within standard literature, project-specific part numbers and options shall be highlighted by enclosing the project-specific information (circling, clouding, text boxes) and other information shall be crossed out. Any deviations to these specifications must be listed on a separate page referencing the specification section with a brief description of the deviation and why it is equal to or superior to what is specified.

B. Submit the following control panel shop drawings in a single package:

1. Layout diagrams for all control panels and enclosures. Include panel elevations (front, side, interior), and sizing. Panel front elevations shall be of sufficient scale to allow all engraved nameplates and inscriptions to be legible without the use of schedules.

2. Wiring diagrams for all control panels. Diagrams shall be complete electrical wiring diagrams showing all components and all auxiliary devices such as relays, alarms, fuses, lights, fans, heaters, etc. All wires and terminals shall be numbered on the diagrams, and line cross references shall be labeled. Include wiring interface to the SCADA controllers where applicable. Include on these drawings, a tag number to identify each component, referenced to a component identification list.

3. Power requirements and heat dissipation summary for all control panels. Power requirements shall state required voltages, currents, and phase(s). Heat dissipations shall be maximums and shall be given in Btu/hr. Summary shall be supplemented with calculations.

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1.06 WARRANTY

A. The system warranty shall consist of a full scope, in-place warranty, consistent with the provisions of the Terms and Conditions of the RFP and the Contract Documents. The warranty duration shall be 12 months beyond Final Acceptance. All hardware components that are part of the completed system shall be covered by the warranty. The control panel supplier shall coordinate any warranties provided by third party suppliers.

PART 2 - PRODUCTS

2.01 CABINET

A. Cabinets and panels with any dimension 36 inches or greater shall be provided with removable lifting lugs designed to facilitate safe moving and lifting of the panel during installation. All doors shall be fitted with common keyed locks.

B. Cabinets and panels located outdoors or in areas other than climate controlled (heated and air conditioned) electrical or control rooms, shall be as a minimum 316 stainless steel NEMA 4X construction. Cabinets located in chlorine storage/feed areas shall be of nonmetallic, FRP construction, rated NEMA 4X.

C. Cabinets and panels located indoors within climate controlled (heated and air-conditioned) electrical or control rooms shall be all steel fully enclosed NEMA 12 units with gasketed doors.

D. Cabinets and panels shall have doors on the front and shall be designed for front access. All cabinets shall be fitted with three-point door latches. Door latches for NEMA 4X cabinets shall be all stainless steel. Door hardware on NEMA 4X cabinets located in chlorine storage/feed areas shall be non-corrosive in that environment.

E. All cabinets and panels shall be provided with drawing pockets for as-built panel drawings. One copy of the appropriate panel as-built drawings shall be furnished and left in the pocket of each panel.

F. Cabinets and panels shall be prefabricated cabinets and panels by Hoffman, Rittal, Saginaw, or approved equal.

2.02 PROGRAMMABLE LOGIC CONTROLLER (PLC)

A. Control and data acquisition associated with site equipment shall be performed by a Programmable Logic Controller (PLC).

B. Each PLC and I/O rack shall be equipped with its own regulated power supply module energized from a standard, commercial 120 VAC 60 Hz, single phase source provided by the Uninterruptible Power Supply. Any power transformation, rectification, regulation, or other conditioning necessary shall be provided as part of the unit's power supply package. The module shall have sufficient capability to handle the power requirements for all the PLC components and I/O points, including the required, installed spare I/O capacity.

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C. The PLC shall be Allen-Bradley CompactLogix 1769-L32E or 1769-L35E. A minimum of 768 KB of user memory shall be installed. The actual amount of memory supplied shall be sufficient to provide 20% unused capacity when the entire PLC program, as provided, is loaded and running. Provide industrial Compact Flash module to maintain memory integrity of the PLC program and eliminate the need for downloading system programs from a host computer following temporary (short-term) power failures. PLC shall be capable of executing ladder logic, function blocks, structured text, and sequential flow chart logic.

D. All I/O modules shall be provided with screw-type terminal blocks with barriers between adjacent terminals for connection of field inputs. Terminals shall be suitable for accepting up to and including No. 14 AWG wire. All terminals shall be provided with unique identification. All I/O modules shall be Allen-Bradley 1769 series.

E. The PLC shall communicate with the MBR SCADA system over an Ethernet network.

F. I/O count shall be as required to implement the functional requirements of the system.

1. Size the I/O chassis for the required I/O cards plus the greater of 1 spare module or 10% additional spare I/O of each type.

2. If necessary, use expansion chassis to accommodate these requirements.

2.03 NETWORK SWITCHES AND MODEMS

A. As required to provide Owner with a complete and fully functional system.

2.04 MISCELLANEOUS REQUIREMENTS

A. All material shall be new, unused and actively marketed for new applications when shipped for configuration.

B. Provide ten percent (rounded up) spare fuses (minimum of 10) of each type and rating supplied.

PART 3 - EXECUTION

3.01 FABRICATION

A. Enclosures shall provide mounting for power supplies, control equipment, input/output subsystems, panel-mounted equipment, and appurtenances. Ample space shall be provided between equipment to facilitate servicing and cooling.

B. Enclosures shall be sized to adequately dissipate heat generated by equipment mounted inside the panel. If required, one or more of the following shall be provided to facilitate cooling:

1. Louvered openings near the bottom and top.

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2. Thermostatically controlled, low noise internal air blowers (initial set point 75 °F) to circulate air within the enclosure, maintaining a uniform internal temperature.

3. Thermostatically controlled, low-noise cooling fans to circulate outside air into the enclosure, exhausting through louvers near the top of the cabinet (NEMA 12 cabinets only). Air velocities through the enclosure shall be minimized to assure quiet operation.

4. All openings in cabinets and panels shall be fitted with dust filters.

C. Enclosures shall be constructed so that no screws or bolt heads are visible when viewed from the front. Punch cutouts for instruments and other devices shall be cut, punched, or drilled and smoothly finished with rounded edges.

D. Terminals shall be marked with a permanent, continuous marking strip. One side of each terminal shall be reserved exclusively for field incoming conductors. Common connections and jumpers required for internal wiring shall not be made on the field side of the terminal.

E. Wiring shall comply with accepted standard instrumentation and electrical practices. Power, control and signal wiring shall comply with Division 26 of the specifications.

F. Separate terminal strips shall be provided for each type of power and signal used within each cabinet.

G. All wiring shall be bundled and run open or enclosed in vented plastic wireway as required. Wireways shall be oversized by a minimum of 10%; overfilled wireways shall not be acceptable. All conductors run open shall be bundled and bound at regular intervals, not exceeding 12 inches, with nylon cable ties. Care shall be taken to separate electronic signal, discrete signal, and power wiring.

H. A copper 120 VAC ground bus shall be installed in each cabinet, and shall be connected to the building power ground. A separate, isolated copper ground bus shall be installed in each cabinet for the logic (24 VDC) ground. Both ground buses shall be clearly labeled as to voltage and function.

I. All interior panel wiring shall be labeled and uniquely identified.

J. Enclosures shall be provided with a main circuit breaker and a circuit breaker on each individual branch circuit within and distributed from the panel. Main breaker and branch breaker sizes shall be coordinated such that an overload in a branch circuit will trip only the branch breaker but not the main breaker.

K. The power entrance to the panel shall be provided with a surge protection device.

L. The control panel shall be the source of power for all 120 VAC devices interconnected with the control panel including, but not limited to:

1. Solenoid valves

2. Electrically actuated valves

3. Instruments connected to the control panel.

M. Door mounted HOA switches shall be provided for all solenoid and non-modulating valves.

N. Fuse holders shall be indicating type.

O. A panel mounted UPS shall be included in each PLC cabinet. The UPS shall be sized to provide at least 30 minutes of run time for the PLC. The UPS shall also power any door mounted operator interface if included.

P. Intrinsic safety barriers shall be provided for all equipment signals originating in a hazardous area.

Q. Enclosures with any dimension larger than 36 inches shall be provided with fluorescent service lights and 120 VAC duplex receptacles for service equipment. Power to these devices shall be independent from the PLC power supply and its associated uninterruptible power system.

END OF SECTION

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SECTION 45 50 00

DEPLOYABLE, READY-TO-OPERATE microBLOX™ MEMBRANE BIOREACTOR SYSTEM

PART 1 GENERAL

1.01 RELATED DOCUMENTS

The specification sections listed in Table 1.1 below are an integral part of this equipment specification. Please review these sections for additional requirements.

Table 1.1 Reference Sections

Section	Description
012014-1-DS-R6	Ovivo Proposal

1.02 DEFINITIONS

For the purposes of this specification terms have meanings indicated below which are applicable to both the singular and plural thereof:

A. CIP: See Maintenance Clean.

B. Contractor: The company responsible for installation & commissioning of the MBR System, including, but not limited to, site preparation, off system equipment, interconnecting mechanical and electrical runs.

C. Cycle: A continuous period of operation lasting 1,440 minutes.

D. Days: Defined as calendar days and shall constitute twenty-four (24) hours measured from midnight to the next midnight.

E. Diffuser Water Flush Cleaning: Operation by which water is introduced into the air scour lines at sufficient velocity to clean the coarse bubble diffusers of each OMU.

F. Digital Operations: Is specific hardware with a suite of digital training and operational support items. Installed on the very iPad platform, Digital Operations offers a highly customized interactive training environment.

G. Engineer: The company responsible for verifying the system selected meets the intent of all governing building, electrical, and treatment codes.

H. Equipment Porch: A dedicated, integral skid, built into the MBR System, where equipment, piping, and controls are attached.

I. FAT: Factory Acceptance Test (FAT) is a full system readiness test conducted at the MBR System Suppliers facility prior to shipment. This may include checks for mechanical inspection, hydraulic system operation, training for end users and maintenance procedures.

J. Flux: Gallons of permeate flow per day per square foot of membrane area (gfd). Additional definitions of flux that are used to characterize design criteria and membrane performance include:

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1. Gross Flux or Instantaneous Flux: Calculated by dividing measured permeate flow rate by working membrane area at any instant.

2. Net Flux: Calculated by dividing the total amount of permeate produced (available for discharge) in a given time frame by the working membrane area.

K. Localized Dewatering: Synonymous with clogging, sludging and plugging. Localized dewatering is the excessive accumulation of solids at a membrane surface in the form of refractory cake and generally in discrete, localized areas. Often caused by excessive filtration in combination with unequal or inadequate air scouring.

L. Maintenance Clean (CIP): Synonymous with chemically enhanced backwash and CIP. A Maintenance Cleaning is performed in-situ and in mixed liquor or activated sludge. The procedure is conducted by charging cleaning chemicals to membranes in the reverse direction of permeate flow with a soak time lasting more than 0.5hr

M. MBR System: A fully inclusive MBR System of equipment, tankage, and controls, pre-engineered to be ready-to-operate upon delivery.

N. MBR System Supplier: The company responsible for providing all equipment and services as described herein and for providing warranty support.

O. Mechanical Cleaning: Synonymous with manual cleaning, physical cleaning and hand cleaning. Mechanical Cleaning is any instance where membranes are cleaned by hand or machine (water jetting or other) for the purposes of removing fouling or localized dewatering.

P. Membrane Cassette: Also called a Small Membrane Subunit, the Membrane Cassette is the smallest assembled unit of the Membrane Unit that is designed to be removed from a Membrane Unit and replaced as a complete unit.

Q. Membrane Diffuser: An air diffuser assembly is an aeration device which is used to transfer air and with that oxygen into sewage or industrial wastewater. The diffuser is also used to create sufficient rise velocity between the membrane sheets.

R. Membrane Sheet: A flexible, backwashable assembly consisting of two filtration layers and a drainage layer. The Membrane Sheets are combined to make a Membrane Cassette.

S. Membrane Zone/Tank/MBR: A tank containing one or more Membrane Units. Zones may be individually isolated.

T. Membrane Unit (OMU): Also called a Large Membrane Subunit, the Membrane Unit is an assembly consisting of one or more Membrane Cassettes and an integral diffuser assembly.

U. Off-board: All items that are not assembled in the main zones or reside on the equipment porches.

V. On-board: All items and supplementary tanks that are factory assembled in the main process zones or on the equipment porches.

W. Owner: The owner shall act as the buyer who will also act as the end-user responsible for the operations of the facility.

X. Pre-training: Is a training session conducted at the MBR System Supplier's facility after the FAT is completed and prior to shipment of the system to the site.

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Y. Process Zone: An area in a Process Train designed and operated to meet a specific biological and/or hydraulic treatment objective. Zones may be individually isolated.

Z. Production Capacity: The net permeate flow rate over a given period of continuous operation accounting for CIP procedures and relaxation. Production capacity requirements are given in terms of:

1. Minimum Daily Flow (MnDF): The minimum net daily flow requirement in which the plant must hydraulically and biologically operate. Minimum daily flow could be occasional or sustained indefinitely.

2. Average Daily Flow (ADF): The average daily flow over a month time period.

3. Maximum Daily Flow (MDF): The maximum net daily flow requirement in which the plant must hydraulically and biologically operate. Maximum daily flow could be occasional or sustained indefinitely.

4. Peak Hourly Flow (PHF): The net peak hourly flow requirement generally occurring during wet weather flow conditions and lasting up to 4hr.

5. Peak Day Flow (PDF): The net peak hourly flow requirement generally occurring during wet weather flow conditions and lasting up to 24 hr in non-consecutive days.

AA. MLSS: Mixed liquor suspended solids reported as mg/l.

BB. Permeability: Equals the instantaneous flux rate divided by the transmembrane pressure (TMP). The units of permeability are gfd/psi.

CC. Relaxation: A temporary suspension of membrane filtration with continued air scouring for the purpose maintaining treatment capacity or reducing CIP requirements.

DD. Transmembrane Pressure (TMP): The effective pressure differential across the membrane during normal operation.

EE. Work: A general description for providing Goods and Special Services.

FF. Zone: An isolatable tank section consisting of equipment specific to the determined zone function.

1.03 SUMMARY

A. The MBR System is a complete pre-engineered system for wastewater treatment utilizing activated sludge and submerged membrane units for biological treatment and solids separation.

B. The System Supplier shall conform to the basis of design performance specifications contained within this section, and must fit within the space allocated on the design drawings.

1.04 DESCRIPTION OF WORK

A. This Section specifies the requirements for the furnishing, installing, testing, training, startup and support of all process equipment required for a submerged membrane ultra-filtration bioreactor system for the treatment of wastewater.

B. The MBR System Supplier shall furnish and commission a fully functional and assembled packaged MBR System as describe in this specification, inclusive of all porch-mounted

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equipment, instrumentation, scope-specific piping and electrical systems, controls, tankage and integration.

C. The MBR System Supplier shall provide engineering, design, installation supervision, commissioning support and digital services in support of the treatment system as described in this specification.

D. The Contractor shall furnish all labor, rigging, materials, and incidentals required for the installation of the MBR System in accordance with the installation instructions provided by the Supplier. Once installed, the MBR System shall be complete and operational with all control equipment and accessories as specified herein and described in the Contract Documents.

1.05 SUBMITTALS

A. Project Submittal: The MBR Supplier shall submit to the Engineer manufacturer's complete descriptive information for all equipment, instrumentation, and components in the Supplier's Scope of Supply for the Engineer's approval prior to purchase of equipment. The Supplier is to provide three CDs or link to FTP site containing all submittal information organized and by component, clearly marking options, models, materials, etc. The Project Submittal shall contain the following:

1. System installation drawings, detailing system dimensions, materials, weights, locations of lifting lugs/points, and anchor bolt locations.

2. System mechanical layout drawings, detailing the number of membrane units, air and permeate piping distribution, piping supports, instrumentation and valves, and all other components comprising the MBR system. Drawings will detail information in plan and elevation/section views and include details as necessary to completely describe the installation requirements.

3. Manufacturer's literature for all equipment in MBR Suppliers scope of supply. Literature will include (as applicable):

   a. Pump curves.

   b. Blower curves.

   c. Materials of construction.

   d. Shop drawings showing all dimensions, sizes and locations of anchors.

   e. Minimum, maximum, and design duty points (flow rates and pressures/TDH).

   f. Unit performance and efficiency data.

   g. Motor horsepower and voltage.

   h. Complete wiring and control diagrams which show the point of connection for power supply.

   i. All project-specific installation data for used by the Contractor.

4. Where manufacturers' standard literature is submitted, it shall be clearly marked to indicate which features are to be furnished under this contract.

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5. Process and Instrumentation Diagrams (P&IDs) showing all equipment and instrumentation which will be controlled by the MBR control system.

6. Instrumentation literature and cut sheets, clearly identifying manufacturer, models, ranges, materials of construction, installation details, power supply voltage, wiring information.

7. Valve literature and cut sheets, clearly identifying manufacturer, models, Cv range, materials of construction, pressure rating, and dimensions.

8. Control panel drawings, detailing the interior and exterior layouts, components, panel dimensions, and panel materials of construction and NEMA rating.

9. Control panel component manufacturers' literature, clearly denoting model numbers of all PLC components, relays, terminal blocks, power supplies, buttons, switches, fuse blocks, etc.

10. Control panel wiring schematics.

11. Process control narrative

12. Warranty information, detailing membrane design fluxes for all seasonal flow conditions.

13. System start-up and test procedures.

B. Installation and Operations Manual (IOM): The MBR System Supplier shall furnish one CD and one digital interactive Installation and Operations Manual at least 2 weeks prior to the delivery of the Supplier's system on site. The IOM will include MBR Supplier and manufacturer's manuals and drawings detailing dimensions, locations, wiring information, and any other information necessary to convey the correct assembly, installation and operations of the MBR System components provided by the Supplier. In addition to installation documents, the IOM shall include requirements for the Mechanical Inspection and a schedule of events for the System Commissioning. The Supplier is to provide a web portal link for the digital interactive O&M.

1.06 QUALITY ASSURANCE

A. All the equipment and services specified under this Section shall be furnished by a single manufacturer, and shall be standard units of proven ability as manufactured by a competent organization that is fully experienced, reputable and qualified in the manufacture of the MBR System to be furnished. The equipment shall be designed, constructed and installed in accordance with the best practice and methods, and shall operate satisfactorily when installed.

B. All equipment furnished under this Section shall be new and unused.

C. To show evidence of being able to provide the quality of equipment and services described in this specification, the Membrane System Supplier shall submit their quality system ISO 9001 certification applicable to design, manufacturing, supply, installation, and servicing of wastewater and water treatment plants, associated equipment and systems. The quality system shall be audited by a third party independent inspector. Certification shall remain in effect throughout the project startup. Proof of current certification shall be provided.

D. The MBR System Supplier shall have a minimum of ten-year history of designing packaged MBR wastewater treatment facilities. The history shall include a direct successful record of manufacturing packaged MBR systems, servicing packaged MBR equipment and systems specified herein for a minimum of ten (10) years within the US. Experience must be direct experience of the MBR System Supplier. Experience related to solely Membrane supply or loose

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system supply will not be considered. MBR System Supplier shall provide documentation to support the history as noted.

E. The MBR System Supplier shall have a multidiscipline staff of at least thirty (30) employees dedicated to the MBR product line. Fifteen (15) of those employees shall have at least five (5) years experience in MBR System Supply. Contracted resources will not be considered. MBR System Supplier shall provide documentation to support staff resources available.

F. The MBR System Supplier shall have a registered Professional Engineer on staff with the credentials:

a. Capable of signing & sealing process calculations and system design.

b. Capable of signing & sealing structural calculations and drawings.

G. In addition to qualifications specified elsewhere in the Contract Documents, the MBR System Supplier shall provide documentation for a minimum ten-year history of complete system supply for ten (10) operational and representative packaged MBR installations that meet the following MINIMUM criteria in order to be considered qualified:

1. Referenced projects shall:

a. Have been a pre-engineered package design & complete system supply. Limited supply related to membrane only projects or third party system supply will not be acceptable.

b. Have the capability to operate at high mixed liquor suspended solids (18,500 to 30,000 mg/L).

c. Have a plant or process train design capacity between 10,000 gallons per day to 125,000 gallons per day.

d. Utilize the same type of headworks (aperture/slot size) and MBR as the proposed system.

e. Have been in operation for at least one year at time of bid.

i One plant shall have been in operation for ten years.

f. Have operated within 50% of nominal rated capacity for a minimum of 12 months at time of bid.

1.07 WORK BY OTHERS

A. The following work and scope of supply is specifically excluded from the MBR Supplier scope:

1. Design and Engineering:

a. Architectural.

b. Buried pipe, including soil requirements, thrust blocks, galvanic protection.

c. Tank pads.

d. Support of piping outside of MBR System scope.

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e. Seismic design or calculations other than for seismic anchorage of the MBR system package.

f. Sealing of calculations and drawings.

2. Structural:

a. Building(s), if required, for housing MBR.

b. Tank pads.

c. Anchor bolts for any equipment outside of MBR system.

3. Mechanical:

a. Permeate piping downstream of MBR package and tie points identified on drawings.

b. Plant water.

c. Hoist equipment above the membrane zone for installation and removal of the membrane cassettes.

d. Installation of any kind, including systems within or outside of Scope of Supply.

4. Electrical:

a. Electrical wiring interconnections (including wiring, conduit and other appurtenances required to provide power connections as needed) from the electrical power source to the MBR System Control Panel.

b. Panel boards, transformers, and other equipment necessary to provide power distribution to the MBR System.

c. Network communications connection between the Plant SCADA and the MBR System SCADA (if the two are different).

5. Other:

a. Receiving, unloading and safe storage of equipment at site or a storage facility until ready for installation.

b. Equipment installation.

c. Raw materials, chemicals and utilities during equipment testing. This includes potable water for system function testing and seed sludge per supplier requirements.

d. Laboratory services, operating and maintenance personnel during equipment checkout, startup and operations.

e. Onsite painting or touch-up painting of MBR System, with the exception of painting required due to damage incurred prior to equipment being received onsite.

1.08 WARRANTY

A. MEMBRANE MODULE PERFORMANCE WARRANTY

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1. The MBR System Supplier warrants that the membrane modules will be used for treatment of wastewater and will achieve the effluent water quality indicated herein.

    a. The membrane module warranty shall be from the MBR System Supplier, not the membrane manufacturer.

2. MBR System Supplier Membrane Module Warranty Period shall be a full replacement warranty with a minimum warranty period of 24 months after date of installation.

    a. The MBR System Supplier may offer a longer warranty period.

    b. For Membrane Modules supplied as part of the original equipment installation, the date of installation is the date that the Notice of Substantial Completion is issued.

    c. Any membrane modules replaced under warranty shall assume the remaining warranty of the membrane modules.

3. The MBR System Supplier warrants that the membrane modules will be free from non-conformance in materials, workmanship, membrane integrity failure, and irreversible flux loss.

4. After final acceptance, if the membrane modules are determined to be non-conforming with respect to membrane integrity and/or irreversible flux loss, the MBR System Supplier will remedy.

5. If within sixty (60) days after notification to the MBR System Supplier it has become apparent to the Owner that membrane modules are not able to meet the provisions of the warranty, the Owner may pursue a breach of warranty claim or other available remedies.

6. Limitations of Membrane Module Warranty. Owner recognizes that the occurrence of any of the following shall void the remaining membrane module warranty.

    a. Physical damage or faulty installation of the membrane modules by others.

    b. Unauthorized alteration of components manufactured by MBR System Supplier.

    c. Exposure to chemical or physical conditions outside of the recommended operating range for the membrane modules. Examples of such conditions include:

        i Inappropriate operation of the biological system that results in exposure of the membrane modules to mixed liquor suspended solids concentrations in excess of 20 grams per liter for MBR, for more than 24 hours greater than three times per year or a cumulative total of 72 hours.

        ii Catastrophic exposure to chemicals not normally associated with water or wastewater treatment as a result of accidents, vandalism or other acts outside the bounds of routine and normal treatment plant operation.

        iii Exposure to fats, oils and grease at concentrations greater than 150 mg/l.

        iv Use of chemicals or cleaning procedures other than those recommended and approved by the MBR System Supplier.

        v Exposure of the membranes to treatment or cleaning chemicals at concentrations above levels or contact time or temperatures acceptable to the MBR Supplier. The MBR System Supplier shall provide to the Owner a listing of known water treatment

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and cleaning chemicals and concentrations and time of exposure that could result in a loss of membrane integrity or cause irreversible fouling with the warranty certificate.

d. Improper maintenance of equipment.

e. Failure of the Owner to maintain electronic operational logs.

f. Changes in the MBR System Supplier - established operational and maintenance guidelines cannot be applied retroactively to invalidate the membrane module warranty.

g. The MBR System Supplier is solely responsible for identifying water quality parameters, instrumentation and control programming required to satisfy and maintain membrane module warranty provisions for operation and cleaning. The MBR SUPPLIER shall establish instrumentation alarm and shutdown limits to prevent operation of the equipment outside the established limits.

    i The Owner shall maintain a high speed connection to the processor but all data monitoring shall be the responsibility of the MBR Supplier. The Owner shall not be required to monitor, report or record instrument field data for warranty purposes.

    ii Any event or instance where connectivity is lost or where one or more operating parameters is non-conforming per Contract Documents for a period of one consecutive hour or for a total of six hours or less in each calendar year, shall not reduce or void the membrane warranty.

h. In order to maintain the provisions of the membrane module warranty, the Owner agrees to the following:

    i The Owner will maintain a hand-written log if an occurrence develops that is totally outside the bounds of routine and normal operation or automated operation.

    ii The Owner shall maintain records regarding:

        a) Date and time membranes are taken out of service or cleaned.

        b) Chemical concentration, amount of chemical per treatment and soak time.

        c) MLSS concentration once per day per MBR.

    iii In the event of the warranty claim, the Owner shall provide the MBR System Supplier with electronic and written logs.

i. Aeration without filtration can be required at times for the purposes of mixing and oxygen delivery.

    i Aeration without filtration shall not reduce or void the warranty.

    ii For the first year of service, the MBR System Supplier shall guarantee that the air scouring diffusers will not clog or need manual cleaning under any and all conditions.

    iii If diffusers clog, the MBR System Supplier shall bear all costs to repair or remediate the diffusers and membranes as necessary to fully recover performance at no cost to the Owner.

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B. ANCILLARY EQUIPMENT WARRANTY

1. The MBR System Supplier warrants that the ancillary equipment will be used for treatment of wastewater and will achieve the effluent water quality and flow indicated herein.

   a. The ancillary equipment warranty shall be from the MBR System Supplier, not the membrane manufacturer.

2. MBR System Supplier Membrane Module Warranty Period shall be a full replacement warranty with a minimum warranty period of 24 months after date of installation.

   a. The MBR System Supplier warrants that the equipment will be free from non-conformance in materials and defects in workmanship.

   b. The warranty period shall begin following completion of the System Commissioning as specified herein.

1.09 GUARANTEE

A. SYSTEM PROCESS GUARANTEE

1. The MBR System Supplier guarantees the system will be used for treatment of wastewater and will achieve the effluent water quality indicated herein.

2. The Process Guarantee Period shall be a minimum period of 12 months after date of successful completion of the Membrane System Commissioning, contingent on the following:

   a. Satisfactory performance of the Goods to achieve equipment performance (e.g. design flows, backwash, chemical washing and Clean-In-Place intervals) and water quality (e.g. integrity failure) objectives.

   b. The influent process parameters listed in warranty statement.

   c. The minimum mixed liquor temperatures as shown in the warranty statement.

   d. The design mixed liquor suspended solids in the MBR as reflected in the process design and/or warranty statement.

   e. Addition of supplemental chemicals for aiding specific nutrient removal as reflected in the process design and/or warranty statement.

   f. The Owner shall maintain a high speed connection to the processor but all data monitoring shall be the responsibility of the MBR System Supplier.

   g. A change in operational parameters and protocols (e.g. backwash, chemical washing or chemical cleaning) will not represent an increase in the operational or membrane replacement cost to the Owner.

3. In the event that the Owner does not believe that the Goods meet the Contract Documents, the Owner shall notify the MBR System Supplier that the conditions for a breach of guarantee exists.

   a. The Owner shall make available to the MFEM electronic records for MFEM review.

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b. The Supplier shall provide an acceptable remedy to the Owner in accordance with the contract documents.

PART 2 PRODUCTS

2.01 ENGINEERING AND DESIGN SERVICES

A. The MBR System Supplier will provide the following services for items in their Scope of Supply:

1. Biological Process Design Verification – The MBR Supplier shall support the Engineer in providing analysis and verification of the biological process design using EnviroSim BioWin wastewater modeling software and the customer's influent mass loading, diurnal flow curves, peak flow/loading numbers, and permit limits. The Suppler shall verify zone volumes; recycle rates, aerations requirements, chemical dosing requirements, and waste solids projections. The supplier shall provide a written report summarizing the modeling results.

2. The Supplier will provide assistance to the Owner and Contractor and provide the information needed to coordinate the interface of the membrane bioreactor system into the overall facility.

3. The membrane bioreactor system piping shall be designed by the MBR Supplier to consider horizontal and vertical orientations and consider air entrainment, siphoning, air or vacuum binding, surging, and other transient fluid flow effects. Modifications to the P&ID supplied for this project may be considered based upon hydraulic considerations.

4. The membrane bioreactor system piping arrangement drawings shall be provided and detail the physical location and placement of valves and valve actuators and instrumentation. Provisions shall be made for the disassembly and maintenance of component equipment.

5. The membrane bioreactor system electrical arrangement drawings shall be provided and detail the physical location and placement of conduit runs, and the internal/external components of the PLC and MCP, electrical ratings, electrical schematics, network interconnect diagram and riser diagrams.

6. The MBR System Supplier shall assign a project engineer for the requirements of the project and for the duration from engineering through the correction period. The project engineer shall be on staff and be a single source of contact between the Supplier and the Owner as long as the project engineer is employed by the MBR System Supplier. The project engineer may only be changed by mutual agreement of the Owner and Supplier.

2.02 SYSTEM PERFORMANCE REQUIREMENTS

A. The biological treatment design shall be based on a biological nutrient removal process that will meet the effluent criteria.

B. The MBR system shall be configured such that seasonal, diurnal, and peak flows shall be equalized in order to accommodate no more than 35,000 gallons per day at a single flux rate that shall not exceed 3.4 gfd.

C. The minimum sludge retention time (SRT) shall be a minimum of 29days.

D. The MBR Zone mixed liquor suspended solids (MLSS) concentration shall be between 10,000 and 15,000 mg/L.

E. Actual Oxygen Demand (AOR) shall not exceed 940 lb/day.

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F. The MBR System shall meet the redundancy and reliability requirements for an EPA Reliability Class II facility. Redundant mechanical equipment such as pumps and blowers shall be provided. A minimum of two treatment trains shall be provided.

G. The MBR System shall be configured to hydraulically equalize seasonal and diurnal flows shown in Table 2-1 and Table 2-2.

Table 2-1: Plant Hydraulic Flow Criteria

Parameter (Flows)	Influent		Event Duration	Frequency	Sequential Duration
Maximum Daily Flow (MDF)[1]	35,000	GPD	365 days	1/yr	Consecutive
Peak Daily Flow (PDF)	35,000	GPD	24 hours	8/yr	Non-Consecutive
[Peak Hour Flow (PHF)	35,000	GPD	4 hours	8/yr	Non-Consecutive

Notes:
1. MDF conditions are central to both biological and hydraulic designs.

H. The MBR System shall be designed to accommodate the diurnal pattern indicated in Table 2-2.

Table 2-2: Diurnal Profile Flow Ratio to (MDF)

Time	Flow Ratio	Time	Flow Ratio	Time	Flow Ratio
00:00 – 01:00	0.600	08:00 – 09:00	1.670	16:00 – 17:00	0.880
01:00 – 02:00	0.350	09:00 – 10:00	1.950	17:00 – 18:00	1.350
02:00 – 03:00	0.295	10:00 – 11:00	2.000	18:00 – 19:00	1.500
03:00 – 04:00	0.230	11:00 – 12:00	1.900	19:00 – 20:00	1.400
04:00 – 05:00	0.191	12:00 – 13:00	1.480	20:00 – 21:00	1.200
05:00 – 06:00	0.228	13:00 – 14:00	1.250	21:00 – 22:00	0.990
06:00 – 07:00	0.368	14:00 – 15:00	0.980	22:00 – 23:00	0.800
07:00 – 08:00	0.938	15:00 – 16:00	0.850	23:00 – 24:00	0.600

I. The MBR System shall be capable of treating raw wastewater at listed flows to the specified effluent criteria shown in Table 2-3.

Table 2-3: Plant Pollutant Loading and Effluent Criteria

Parameter	Influent[1,4,9]	Effluent[6]
COD	5,000 mg/L	< 200 mg/L[8]
$CBOD_5$	5,000 mg/L	< 200 mg/L
TSS	100 mg/L	< 5 mg/L[2]
TKN	70 mg/L[3]	N/A
NH3	50 mg/L[3]	N/A
TN	70 mg/L[3]	N/A
TP	20 mg/L[3]	N/A
Akalinity[7]	N/A	N/A
FOG[8]	N/A mg/L	N/A

Parameter	Value[6]
Effluent Fecal Coliform	N/A
Effluent Turbidity	N/A
Effluent DO	N/A
Influent Min Temp	15 Deg C
Influent Max Temp	25 Deg C
Influent pH	6-8 SU

Notes:
1. Influent loading shall be within ± 5% of MDF design value.
2. Measured TSS shall be less than or equal to 5 mg/L on 9 of 10 consecutive samples.
3. Values are after nutrient addition of DAP and Urea.
4. Influent shall be screened so that at least 85% of solids with any 2 dimensions greater than or equal to 3mm in length are removed.
5. Concentration of grit, defined as particles having a specific gravity of >1.6 and unable to pass through a 65-mesch screen (0.21mm), shall be less than 5 mg/l.
6. Effluent limits are based on measurements using Standard Methods for the Examination of Water and Wastewater (Latest Edition).
7. Water hardness shall not exceed 300 mg/l as CaCO3.
8. FOG shall not exceed 20% of the system BOD.
9. No substances shall be placed in the system in quantities which are not biodegradable or toxic to the biological system.
10. Assumes COD is biologically degradable. 1lb oxygen per lb cod applied.

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J. Site Conditions

1. System location is outdoors.

   a. Ambient air temperatures shall be between 33 °F and [103] °C.

   b. Relative humidity shall not exceed 95%.

2. The elevation above sea level: 500 ft.

3. Seismic

   a. The Supplier shall provide documentation stating that the installed equipment anchorage can meet the following seismic criteria:

      i. GPS Location: 32.3433,-81.2496
      ii. Ss=0.330, S1=0.125
      iii. Site Class = D
      iv. SDs=.389g, SD1=.186g
      v. Seismic Design Category: C.
      vi. Is=1.0

4. System shall meet NFPA 820 standard for fire protection in wastewater treatment systems. - Standard for Fire Protection in Wastewater Treatment and Collection Facilities. MBR System Supplier-provided equipment will be installed in areas that have NEC area classification with a Class 1, Group D, Division 1 envelope and a Class 1, Group D, Division 2 envelope. The Supplier shall provide equipment suitable for installation in this area's classification.

2.03 SUBSYSTEM SCOPE OF SUPPLY

MBR System Supplier shall furnish the Subsystem Components listed below in accordance with the requirements of the project Specifications and Contract Documents.

A. SYSTEM CONFIGURATION

1. The MBR System is to be a complete and functional, factory pre-assembled and factory tested package system for wastewater treatment utilizing activated sludge and submerged membrane units for biological treatment and solids separation.

2. The overall system configuration shall conform to the performance requirements and specifications.

3. All equipment will be pre-assembled and skid mounted as a complete plug and play package unit with steel tanks. All components shall be shipped factory pre-assembled on-board unless otherwise noted.

4. The MBR System must be configured in at least two separate Membrane zones, each of which shall be capable of being isolated and drained for maintenance.

5. Each CIP shall not require the MBR to be drained and shall not require the MBR zone to be taken out of service for more than 4 hours.

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6. The MBR shall utilize progressive cavity pumps to filter water. No additional components such as vacuum pumps and air separators shall be required for filtration purposes.

7. All on-board pumps irrespective of the service shall be of like type and make.

8. Each piece of equipment shall be provided with shut off valves or mechanisms so that it may be isolated or by-passed, while still providing system operation to take place.

9. The main system skid and tank components must be on-board and limited to a maximum of one (1) total complete assembly.

   a. Loose equipment supply or separate skid systems for the main system process equipment is not acceptable, unless noted by this specification otherwise.

   b. Any item noted as off-board or loose equipment supply is to be:

      i. Provided by the MBR Supplier.

      ii. The Contractor responsibility to provide and install anchors, supports, interconnecting piping, electrical and communications.

B. SUBSYSTEM SUPPLY

1. MBR System Supplier shall furnish the Subsystem Components listed below in accordance with the requirements designated herein. Subsystem Components listed as not required are not provided by the MBR Supplier and may be supplied by others only if necessary for a complete and functional system:

   a. System Base

      i. Zones on-board with integral equipment porches.

         a) Quantity, four

      ii. PLC, MCP, HMI and SCADA.

         a) Quantity, one.

         b) Located on the large lower equipment porch.

      iii. Level transmitter(s).

         a) Quantity, three.

         b) Isolation Valve, one per transmitter.

         c) Transmitter #1 is located in the tank wall of MBR Zone #1 and accessible from the large lower equipment porch.

         d) Transmitter # 2 & #3 are located in the tank wall of the PA Zone and is accessible from the outside of the tank.

      iv. Membrane Cleaning System.

         a) Quantity, one.

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b) Mix tank 570 gallons, located on-board.

c) Transfer pump, located on-board in mix tank.

v. 110 VAC Transformer.

a) Quantity, one.

b) Convenience outlets.

c) Porch lights.

d) Located, large lower equipment porch.

vi. Lot of pipe and electrical.

vii. Weirs.

a) Quantity, one

b) Located, in the walls between each MBR zone.

b. System Voltage Transformer, Incoming Voltage.

i. Not required.

c. Headworks.

i. Fine Screen(s).

a) Quantity, one duty, one standby.

b) Located within the Fine Screen enclosure.

ii. Fine Screen enclosure.

a) Quantity, one.

b) Screening chute.

c) Basin isolation valves.

d) Located off of the PA Zone Walls. Shipped loose, bolted in place by the Contractor

iii. Level instruments.

a) Quantity, one high level and two low level switches.

b) Located within the Fine Screen enclosure.

iv. Screening bagging system.

a) Quantity, one.

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b) Located off the Fine Screen enclosure screening chute.

d. Zones.

i. Equalization / Buffer.

a) By Others

ii. Pre-Aeration (PA) Zone.

a) Supplemental tank volume offboard of 70,000 gallons.

b) Coarse bubble aeration and mixing.

iii. Anoxic.

a) Not required.

iv. WAS Storage.

a) By Others

v. MBR Zone(s).

a) Two onboard MBR zone(s) with a minimum total volume of 8,200 gallons.

b) Each zone shall have a total of one OMU.

e. Internal Recycle (IR) Pumps

i. Zone Transfer Pump(s).

a) Quantity, two duty.

b) Isolation valves, two per pump

c) Gauges, two per pump.

d) Located on the large lower equipment porch.

f. Permeate Collection.

i. Permeate Pump(s).

a) Quantity, one duty, one standby.

b) Isolation valves, two per pump.

c) Gauges, two per pump.

d) Check valve, one per pump.

e) Sample port.

f) Located on the large upper equipment porch.

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ii. TMP measurement.

a) Quantity, one.

b) Located on the permeate header on the large upper equipment porch.

iii. Flow meter.

a) Quantity, one

b) Located on the large lower equipment porch.

iv. Solenoid Valve.

a) Quantity, two.

b) Located on the large lower equipment porch.

g. Disinfection.

i. Not required.

h. Supplemental Oxygen.

i. Not required.

i. Blowers.

i. Blower(s).

a) Quantity, five duty, one standby.

b) Isolation valve, one per blower.

c) Pressure relief valve, one per blower.

d) Pressure gauge, one per blower.

e) Check valve, one per blower.

f) Branch isolation valves.

a) Quantity, six

b) Located on the air header on the large upper equipment porch n on blower skid.

j. Analytics.

ii. Turbidity.

a) Sensor, quantity one.

b) Controller, quantity one (may be combined with other analytics).

c) Sample Pump, quantity one (may be combined with DO).

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d) Located on the large lower equipment porch.

iii. Dissolved Oxygen.

a) Probe, quantity one.

b) Controller, quantity one (may be combined with other analytics).

c) Sample pump, quantity one (may be combined with Turbidity).

d) Flow cell, quantity one.

e) Located in PA Tank.

iv. TSS.

a) Not required.

v. Influent BOD, TSS, TKN, NH3 and NO3 Monitoring System.

a) Not required.

vi. Effluent BOD, TSS, TKN, NH3, NO3 and EColi Monitoring System.

a) Not required.

k. Chemical Addition.

i. Chemical addition system.

a) Meter pump, quantity five.

b) Meter pump located on large lower equipment porch, chemical drum located off-board.

l. Options.

ii. Covers.

a) Not required.

iii. Walkway.

a) Located between the tanks. Shipped loose, bolted in place by the Contractor.

iv. 316 SS Fasteners.

a) Not required.

v. Heat Tracing.

a) Not required.

b) Located on liquid pipe and equipment.

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vi. Remote Disconnects.

a) Not required.

b) Located local to equipment.

vii. Stairs.

a) Quantity, one.

b) Shipped loose and bolted into place by the Contractor.

c) Located at the upper porch access points.

m. Supplemental Pumps

viii. WAS

a) Quantity, one duty, one standby.

b) Isolation valves, two per pump.

c) Gauges, two per pump.

d) Check valve, one per pump.

e) Located off-board.

ix. EQ

a) By Others

x. Lift Station

a) By Others

2.03 GENERAL EQUIPMENT DESIGN, PERFORMANCE AND ASSEMBLY REQUIREMENTS

The requirements listed below are in addition to those called out in other sections. The MBR System includes all necessary subsystems to form a complete functional wastewater treatment plant. Subsystems are designed in accordance with the functional requirements described herein.

A. SUBSYSTEM BASE

1. General

a. System Operating Power Requirements

i. 480VAC/3PH/60Hz

a) 200 Amp panel is to be provided by others.

ii. A transformer may be supplied for voltage other than 480VAC/3PH/60Hz power.

b. Weight

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i. Shipping weight, empty

a) 38,000 lbs., microBLOX.

b) 15,000 lbs. PA1 Tank

c) 15,000 lbs PA2 Tank

ii. Operating weight, full

a) 118,000lbs., microBLOX.

b) 275,000 lbs., PA1 Tank.

c) 275,000 lbs PA2 Tank

c. Unless otherwise noted as off-board, subsystem components shall be factory installed, pre-plumbed and pre-wired.

d. Subsystem controls will be integrated into the PLC and SCADA within the MBR system Panel.

e. Motor control and HOA will be integrated into the MBR System Panel.

f. Electrical material and equipment shall have UL listing wherever standards have been established by that agency.

g. Complete electrical assembly shall meet all requirements of the National Electrical Code, the National Electrical Manufacturers Association (NEMA), the National Fire Protection Association (NFPA), and all applicable state and local codes.

h. All field instruments shall have identification tags meeting the following requirements:

i. Tag number of instruments shall match supplied P&IDs

ii. Tags shall be made of one of the following, depending on locations:

a) Stainless steel, engraved with 3/16-inch letters, and attached using a stainless steel cable.

b) Phenolic plastic with 3/16-inch letters, attached with double-faced tape.

2. Steel Tanks

a. See Section 2.04 Fabrication Requirements for design parameters.

3. Composite Tanks

a. See Section 2.04 Fabrication Requirements for design parameters.

4. Integration and Controls

a. MBR System Control Panel

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i. The system shall include one single panel, factory installed on the lower porch. The panel shall include components for the PLC, Motor Controls, HMI and HOAs.

ii. The panel shall be shipped factory installed and pre-wired to motors and components by the System Supplier.

iii. The panel shall be NEMA 4X rated.

iv. A UPS shall be included.

v. Climate control shall include:

a) Heater
b) Air conditioner in NEMA 4X housing.

b. PLC

i. The PLC shall be provided to control equipment included with the MBR System package. The PLC shall provide the functions described by the P&IDs and control narrative. The PLC program will be thoroughly documented to facilitate future troubleshooting or modifications.

ii. The System Supplier shall supply all equipment and custom software programming as required for a fully operational system, and shall provide the necessary hardware/software to allow for remote monitoring of the MBR System.

iii. The System Control Panel shall be factory installed on the Equipment Porch and pre-wired to other components on the Equipment Porch. Contractor to provide electrical power and conduit to the panel and between the panel and any electrical items shipped separate from the Equipment Porch.

iv. PLC Manufacture and Processor Model: Allen Bradley CompactLogix L32E.

c. SCADA System

i. Plant SCADA system shall include the following:

a) Graphical interface

b) Trending capability

c) Remote monitoring

d) Remote alarming

e) Remote plant control

ii. Remote monitoring and alarming shall include telephone contact to the plant Operator.

iii. A wireless station shall be factory installed in the panel so that a Digital OPS system may access digital functions within the area of the system.

iv. Plant SCADA system shall be run on a 10.4“ TFT VGA display panel mount operator interface located in the System Control Panel and factory installed.

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v. Software: Red Lion Crimson, G310S230

5. Motor Controls

   a. Motor Control Panel

      i. The motor controls shall be provided to control equipment included with the MBR System package. The MCP is integral with the MBR System Control Panel and shall provide Starters and VFDs as required for the system.

      ii. Potentiometers for manual control of each variable frequency drive (VFD) shall be provided to allow for temporary manual operation.

      iii. Hand-Off-Auto (HOA) switches for all major equipment shall be provided to allow for temporary manual operation.

6. Level Transmitter(s)

   a. A digital pressure transmitter shall be used as a level sensor to measure water level in the zone.

   b. The level instrument shall be wall mounted.

   c. The instrument shall have a local read out as well as the interface with the PLC.

   d. The instrument shall be provided with an isolation valve so that the instrument can be replaced without having to drain the basin.

   e. Manufacturer and Model: Endress & Hauser Cerabar PMP71

7. Membrane Cleaning System.

   a. Mix tank 570 gallons, located off-board.

      i. The tank height shall be a maximum 4.6'.

   b. Transfer pump, located off-board in mix tank.

      i. Design Basis:

a)	Service:	Chemical Transfer
b)	Motor Duty:	Intermittent
c)	Minimum Flow Rate:	12.5 gpm
d)	Maximum Flow Rate:	41.7 gpm
e)	Maximum TDH:	20' ft
f)	Motor size:	.3 HP
g)	Motor Voltage:	120VAC/31PH/60Hz
h)	Motor Enclosure:	TEFC

      ii. Manufacturer and Model: Dayton 3YU56

8. 110 VAC Transformer.

   a. A transformer shall be utilized to provide 110 VAC service to miscellaneous components, lights and convenience outlets.

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b. Primary 480VAC/1PH/60Hz, secondary 110VAC/1PH/60/Hz.

c. The transformer shall be shipped factory installed and pre-wired by the System Supplier

9. Lot of Pipe and Electrical.

a. Pipe, shall be factory installed.

i. Liquid Service.

a) PVC schedule 80 or 204 stainless

ii. Air.

a) 304 Stainless.

b. Electrical, shall be factory installed.

a) Water tight conduit.

10. Weirs.

a. Weirs shall allow the following service:

i. Hydraulically link zones.

ii. Isolated zones.

iii. Provide an over flow weir.

b. Size shall be 1'-0" wide x 2'-6" height.

c. A handle shall be provided for ease of removal.

d. Manufacturer and Model: Halliday Series N1A

B. SUBSYSTEM VOLTAGE

1. For incoming voltage other than 480V/3PH/60HZ the system supplier shall provide a voltage transformer to accommodate the difference in incoming voltage with the requirements of the MBR System.

a. None Required.

C. HEADWORKS SUBSYSTEM

1. General.

a. Subsystem components shall be used to screen incoming solids and convey them to a trash dispenser.

b. Unless otherwise noted as off-board, subsystem components shall be factory installed, pre-plumbed and pre-wired.

c. Subsystem controls will be integrated into the PLC and SCADA within the MBR system Panel.

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d. Motor controls and HOA will be integrated into the MBR System Panel.

2. Fine Screen(s).

a. The MBR System is equipped with automatic bar screen(s) to remove solids from incoming sewage. The screening system shall be the automatic self-cleaning type with vertical bars and multiple rakes to carry the screenings upward to a discharge point.

b. The supplied screening equipment is sufficient to meet Membrane Warranty and Performance requirements.

c. Capture rate: Influent shall be screened so that at least 85% of solids with any 2 dimensions greater than or equal to 3 mm in length are removed.

d. The headworks shall be sized with sufficient capacity to handle 110% of the maximum hydraulic flow as stated table 2.1.

e. The fine screen(s) shall be shipped factory installed and pre-wired by the System Supplier.

f. Motor controls and HOA shall be located in the MBR System Control Panel.

g. The rakes shall be manufactured from corrosion resistant Rynite PET. The rakes engage the screen to remove trapped material from the downstream side.

h. All materials shall be corrosion resistant; Type 304 stainless steel, HDPE plastic, polycarbonate, Rynite, or UHMW. The gear motor shall receive two coats of high build epoxy coating at the factory.

i. Each screen system shall be designed to be self-supporting with a stainless steel frame and flat bar support structure that sits in a specially designed enclosure.

j. Design basis

i.	Service:	Raw Influent Wastewater
ii.	Maximum influent flow rate per unit:	150 gpm
iii.	Hazardous Area Classification:	Class I, Division I
iv.	Material of Construction:	304 Stainless Steel/Rynite
v.	Maximum bar spacing:	2 mm
vi.	Motor size:	0.3 HP
vii.	Motor Voltage:	480VAC/3PH/60Hz
viii.	Motor Enclosure:	TEFC
ix.	Weight Each Motor:	226 lbs
x.	Weight Each Screen:	33 lbs

k. Manufacturer and Model: Ovivo FS-600

3. Screen Enclosure with Chute.

a. The fine screen shall be housed in a fabricated enclosure. Flow shall enter the enclosure through a flanged inlet pipe and screened influent shall be discharged through a flanged outlet in the bottom of the enclosure.

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b. The enclosure will be provided with sealed removable lids to allow access to the screens and the chute for maintenance. The lid shall contain a mechanism to hold the lid open during service.

c. A discharge chute shall be provided to direct screenings to the Owners receptacle.

d. The outlet from the screen enclosure and prior to the inlet to the first tank shall contain an isolation valve.

e. Design basis:

i.	Service:	Raw Influent Wastewater
ii.	Material of Construction:	304 Stainless Steel
iii.	Material Thickness:	10 gauge
iv.	Number of Chambers:	Two
v.	Weight:	285 lbs.

f. Manufacturer and Model: Ovivo 595-107

4. Level Switches.

a. All configurations will include level switches for automatic start/stop of each fine screen and detection of an overflow.

b. Design Basis:

i.	Service:	Raw Influent Wastewater
ii.	Hazardous Area Classification:	Class I, Division I
iii.	Switch Type:	Mercury
iv.	Actuation Point:	1” Above/Below Horizontal
v.	Material of Construction (housing):	Polypropylene
vi.	Maximum Operating Temperature:	170°F
vii.	Minimum Operating Temperature:	32°F
viii.	Electrical Rating:	120VAC/10A
ix.	Weight each unit:	1.22 lbs.

c. Manufacturer and Model: Conery 2902-B1-S2-C1

5. Screening Bagging System.

a. Screenings shall be discharged through a discharge chute fabricated to accept the screenings into a continuous closed bag system.

b. The bagging system shall provide odor containment.

c. Design Basis:

i.	Service:	Screen Material
ii.	Type:	Continuous Bag
iii.	Material of Construction (bag holder):	304 Stainless Steel
iv.	Material of Construction (continuous bag):	Polyethylene

d. Manufacturer and Model: InnoKom, Longofill

D. ZONES, ONBOARD SUBSYSTEMS

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1. General.

   a. Subsystem components shall be used to build out system zone configuration.

   b. Unless otherwise noted as off-board, subsystem components shall be factory installed, pre-plumbed and pre-wired.

   c. Subsystem controls will be integrated into the PLC and SCADA within the MBR system Panel.

   d. Motor controls and HOA will be integrated into the MBR System Panel.

2. Equalization / Buffer Zone.

   a. Not Required.

3. PA Zone.

   a. The PA zone shall be used for biological treatment.

   b. Aeration.

      i. The zone shall be equipped with fine bubble diffusers to sufficiently supply air for biological purposes. The amount of air shall be no more than 160 scfm for the PA 1A and 75 scfm for PA1B .

      ii. The diffusers shall be located in the center of the tank.

      iii. Design Basis:

a)	Service:	Biological Process Mixing
b)	Air Flow Source:	Blower
c)	Flow Control Method:	On/Off

      b) Manufacturer and Model: Aerostrip Flat Panel

4. Anoxic Zone.

   a. Not Required.

5. WAS Zone.

   a. Not Required.

6. MBR Zone.

   a. MBR process zones shall be used for biological treatment and to house the OMUs used to separate effluent from mixed liquor.

   b. Membrane Units (OMU).

      i. OMUs shall be comprised of a diffuser case and membrane cassettes.

      ii. OMUs shall be constructed of type 304 stainless steel, PVC, and PE components as necessary for operation submerged in mixed liquor as part of an MBR System.

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iii. Membranes shall be flat-sheet style membranes with two PES (polyethersulfone) filtration layers uniformly fused to and separated by an integral polyester (PE) drainage layer.

a) Sheet shall be 2mm in thickness, 8 mm apart and sufficiently flexible to minimize or prevent the effects of localized dewatering.

b) Sheet shall be ultrasonically welded on all sides and backwashable.

iv. Diffusers cases shall consist of a diffuser housing with individual medium bubble diffusers, each fed by a common manifold and easily replaceable.

a) The assembly shall consist of an adjustable diffuser orientation for rise rate and oxygen transfer efficiency (OTE) optimization ±20º (total of 40º) in fixed 5º intervals

v. OMUs shall be capable of being aerated during periods of no filtration.

vi. OMUs shall have integral diffuser and permeate manifolds.

vii. OMUs shall be easy to recover from localized dewatering or clogging in the event of miss-operation or operation outside of normal operating conditions.

a) Only a routine Maintenance Cleaning shall be required following a dewatering event to recover Specified performance

b) In situ physical or mechanical cleaning only, no manual cleaning shall be required to recover

viii. OMU's shall be resistant to damaging debris and self-heal in terms of effluent quality per the following:

a) Turbidity shall recover to specified limits within 10 minutes of a damaging event or occurrence provided the resulting cut or abrasion is less than 4" in total length.

ix. OMUs shall be prefabricated, preassembled and factory certified before shipment to the site. Membrane units shall be installed at the factory. No installation of membranes units shall be done onsite.

x. The membrane module shall be approved by the California Department of Health Services (DHS) under the California Recycled Water Criteria (Title 22 of the California Code of Regulations). Submitters shall provide a copy of the DHS acceptance letter and test report.

xi. Design Basis:

a)	Service:	Aerated Biological Zone
b)	Material of Construction (membrane):	Polyethersulfone (PES)
c)	Material of Construction (diffuser):	304 Stainless Steel
d)	Maximum Solids Concentration:	30,000 mg/L
e)	Maximum TMP:	6 psi
f)	Nominal | Effective Pore Size:	<0.04 μ | <0.01 μ
g)	Surface Area per OMU:	5,167 ft^2
h)	Max Air Scour Rate per OMU:	75 scfm
i)	Air Flow Source:	Blower

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j) Diffuser Type: Medium Bubble
k) Diffuser minimum OTE: 1.3%/ft

xii. Manufacturer and Model: Ovivo OV480

E. INTERNAL RECYCLE TRANSFER PUMP SUBSYSTEM

1. General

a. Subsystem components shall be used to recycle water from the onboard MBR zone to the PA zone.

b. Unless otherwise noted as off-board, subsystem components shall be factory installed, pre-plumbed and pre-wired.

c. Subsystem controls will be integrated into the PLC and SCADA within the MBR system Panel.

d. Motor controls and HOA will be integrated into the MBR System Panel.

2. Transfer Pumps

a. Each pump shall be a close-coupled dry-mounted, progressive cavity pump.

b. Pump motor shall be inverter-duty rated and operated via Variable Frequency Drives.

c. Major pump components shall be cast iron for casings and NBR (Perbunan®) for stators and joint sleeves, and 316SS rotor and shaft. Mechanical seal materials shall be solid silicon carbide faces with 316 stainless steel metal parts and Viton elastomers.

d. Design Basis:

i.	Service:	Screened Influent Wastewater
ii.	Maximum Solids Size:	1/2 in
iii.	Maximum Viscosity:	500 cp
iv.	Minimum Flow Rate:	7.5 gpm
v.	Maximum Flow Rate:	130 gpm
vi.	Maximum Suction Lift:	20 ft
vii.	Maximum Discharge pressure:	30 psig
viii.	Motor size:	10 hp
ix.	Motor Voltage:	480VAC/3PH/60Hz
x.	Motor Enclosure:	TEFC
xi.	Noise Level:	70 dBa @ 20’
xii.	Weight each:	330 lbs.

e. Manufacturer and Model: Seepex BN-17 6L

3. Isolation Valve

a. Each pump shall have isolation valves on the inlet and outlet, to provide for ease of maintenance and removal.

b. Valves shall be full port true union ball valves.

c. Design Basis:

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i. Service: Screened Influent Wastewater
ii. Type: Full Port True Union Ball Valve
iii. Pressure Rating: 230 PSI
iv. Material of Construction (body): Schedule 80
v. Material of Construction (o-rings): EPDM
vi. Weight each: 6.17 lbs.

d. Manufacturer and Model: Asahi/America Type 21

4. Pressure Gauge

a. Each pump shall have pressure on the inlet and outlet, to provide for ease of operational verification.

b. Gauges shall be for applications involving vibration or pulsation.

c. Design Basis:

i. Service: Screened Influent Wastewater
ii. Type, Inlet Gauge: Compound
iii. Type, Outlet Gauge: Pressure
iv. Range, Inlet Gauge: 0-30 psi
v. Range, Outlet Gauge: 30”Hg-0-15psi
vi. Material of Construction (body): Stainless Steel
vii. Filling: Glucerin
viii. Weight each: 6.17 lbs.

d. Manufacturer and Model: McDaniel 2 ½ “

F. PERMEATE COLLECTION SUBSYSTEM

1. General

a. Subsystem components shall be used to pull filtered water through the membrane(s).

b. Unless otherwise noted as off-board, subsystem components shall be factory installed, pre-plumbed and pre-wired.

c. Subsystem controls will be integrated into the PLC and SCADA within the MBR system Panel.

d. Motor controls and HOA will be integrated into the MBR System Panel.

2. Permeate Pump

a. The Permeate Pump shall be designed to create a vacuum on the permeate headers so that filtered water is easily pulled through the membrane surface.

b. Each Pump shall be a close-coupled dry-mounted, progressive cavity pump.

c. Major pump components shall be cast iron for casings and NBR (Perbunan®) for stators and joint sleeves, and 316SS rotor and shaft. Mechanical seal materials shall be solid silicon carbide faces with 316 stainless steel metal parts and Viton elastomers.

d. No additional components such as vacuum pumps and air separators shall be required for filtration purposes.

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e. Pump motor shall be inverter-duty rated and operated via Variable Frequency Drives.

f. Design Basis:

i.	Service:	Screened Influent Wastewater
ii.	Maximum Solids Size:	1/2 in
iii.	Maximum Viscosity:	500 cp
iv.	Minimum Flow Rate:	7.5 gpm
v.	Maximum Flow Rate:	44.5 gpm
vi.	Maximum Suction Lift:	20ft
vii.	Maximum Discharge pressure:	35 psig
viii.	Motor size:	5 hp
ix.	Motor Voltage:	480VAC/3PH/60Hz
x.	Motor Enclosure:	TEFC
xi.	Noise Level:	70 dBa @ 20’
xii.	Weight each:	330 lbs.

g. Manufacturer and Model: Seepex BW-10

3. Isolation Valve

a. Each pump shall have isolation valves on the inlet and outlet, to provide for ease of maintenance and removal.

b. Valves shall be full port true union ball valves.

c. Design Basis:

i.	Service:	Permeate
ii.	Type:	Full Port True Union Ball Valve
iii.	Pressure Rating:	230 PSI
iv.	Material of Construction (body):	Schedule 80
v.	Material of Construction (o-rings):	EPDM
vi.	Weight each:	6.17 lbs.

d. Manufacturer and Model: Asahi/America Type 21

4. Pressure Gauge

a. Each pump shall have pressure on the inlet and outlet, to provide for ease of operational verification.

b. Gauges shall be for applications involving vibration or pulsation.

c. Design Basis:

i.	Service:	Permeate
ii.	Type, Inlet Gauge:	Compound
iii.	Type, Outlet Gauge:	Pressure
iv.	Range, Inlet Gauge:	0-30 psi
v.	Range, Outlet Gauge:	30”Hg-0-15psi
vi.	Material of Construction (body):	Stainless Steel
vii.	Filling:	Glucerin
viii.	Weight each:	6.17 lbs.

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d. Manufacturer and Model: McDaniel 2 ½ "

5. Check Valve

a. Each pump shall have a check valve on the outlet, to prevent water returning back into the pump.

b. Design Basis:

i.	Service:	Permeate
ii.	Type:	Swing or Ball
iii.	Pressure Rating:	230 PSI
iv.	Material of Construction (body):	Schedule 80
v.	Material of Construction (o-rings):	EPDM
vi.	Weight each:	6.2 lbs.

c. Manufacturer and Model: Asahi

6. Transmembrane Pressure Measurement (TMP)

a. Permeate Pressure transmitter shall be used for calculating the TMP of the membrane units.

b. The TMP pressure transmitter shall produce a 4-20mA signal for PLC input.

a. Design Basis:

i.	Service:	Permeate
ii.	Area Classification Rating:	Class 1, Division 2
iii.	Type:	Pressure Transducer
iv.	Local Display:	None
v.	Pressure Range:	0 to 15 psi
vi.	Accuracy:	<0.5%
vii.	Ambient Temperature:	-4° to 185°F
viii.	Material temperature:	-4° to 212°
ix.	Supply Voltage:	24 VDC.

b. Manufacturer and Model: Endress + Hauser Cerabar PMC131

2. Permeate Flow Meter

a. The flow meter shall be used to measure the instantaneous flow of treated effluent.

b. The flow meter shall produce a 4-20mA signal for PLC input.

c. Design Basis:

i.	Service:	Permeate
ii.	Area Classification Rating:	Class 1, Division 2
iii.	Type:	Electromagnetic
iv.	Local Display:	LCD, 2 Line Display
v.	Flow Range:	7 to 190 gpm
vi.	Accuracy:	<0.5%
vii.	Ambient Temperature:	-4° to 140°F
viii.	Material temperature:	-4° to 122°F

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ix. Supply Voltage: 24 VDC.

d. Manufacturer and Model: Endress & Hauser Promag 10W

3. Solenoid Valve

a. Solenoids shall be provided as a positive shut off to prevent syphoning of the filtered water when the system is in intermittent mode.

b. The flow meter shall produce a 4-20mA signal for PLC input.

c. Design Basis:

i.	Service:	Permeate
ii.	Area Classification Rating:	Class 1, Division 1
iii.	Type:	Coil
iv.	Material of Construction (body):	304 Stainless Steel
v.	Material of Construction (seal):	NBR
vi.	Ambient Temperature:	32° to 125°F
vii.	Material temperature:	32° to 125°F
viii.	Supply Voltage:	120VAC/1PH/60Hz.

d. Manufacturer and Model: Endress & Hauser Promag 10W

G. DISINFECTION SUBSYSTEM

1. General

a. Not Required

H. SUPPLEMENTAL OXYGEN SUBSYSTEM

1. General.

a. Not Required

I. BLOWER SUBSYSTEM

1. General.

a. Blowers provide air scour to the membranes and oxygen into the biological process.

b. Blowers provide aeration and mixing to the PA zones.

c. Blowers shall have sufficient capacity to provide constant aeration to all OMUs continuously

a. Unless otherwise noted as off-board, subsystem components shall be factory installed, pre-plumbed and pre-wired.

b. Subsystem controls will be integrated into the PLC and SCADA within the MBR system Panel.

c. Motor controls and HOA will be integrated into the MBR System Panel.

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2. Blower.

   a. Aeration Blower shall be a Regenerative type.

   b. Blowers shall be sized such than sufficient OMU scour air is provided to support flows as described in this Specification without requiring additional maintenance cleans.

   c. Blowers shall accommodate a minimum surge or 1.5 psig under normal operating conditions.

   d. Blowers shall be provided complete with inlet and exhaust silencers with filters, pressure relief valves, check valves, motors, pressure gauges, and mounting equipment. Fittings shall be stainless steel.

   e. Design Basis:

i.	Service:	OMU Air Scour, PA aeration
ii.	Discharge Pressure Range:	4.7 to 5.5 psig
iii.	Inlet Temperature:	41°F to 104°F
iv.	Relative Humidity:	90%
v.	Max rated Temp Rise:	130°F @ 5.5 psig
vi.	Blower Speed:	3,450 rpm
vii.	Flow Rate:	170 scfm @ 5.5 psig & 0’ Elevation
viii.	Motor size:	8.5 HP
ix.	Motor Voltage:	480VAC/3PH/60Hz
x.	Motor Enclosure:	TEFC
xi.	Sound Level:	70 dB(A) @ 5’
xii.	Weight each:	154 lbs

   f. Manufacturer and Model: Elmo Rietschle 2BH16107HH46

3. Isolation Valve.

   a. Each blower shall have isolation valves on the outlet, to provide for ease of maintenance and removal.

   b. Valves shall be butterfly valves with 360 degree concentric seating.

   c. Design Basis:

i.	Service:	Air
ii.	Type:	Wafer Butterfly
iii.	Pressure Rating:	250 PSI
iv.	Material of Construction (body):	Cast Iron
v.	Material of Construction (disc):	Aluminim Bronze
vi.	Material of Construction (liner):	EPDM
vii.	Weight each:	10.2 lbs.

   d. Manufacturer and Model: Keystone Figure 221

4. Pressure Relief Valve.

   a. Each blower shall have a pressure relief valve on the outlet, to prevent air or water returning back into the blower.

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b. Design Basis:

i.	Service:	Screened Partially Wastewater
ii.	Type:	Spring
iii.	Pressure Rating:	7 PSI
iv.	Material of Construction (body):	Stainless Steel
v.	Material of Construction (o-rings):	EPDM
vi.	Weight each:	6.2 lbs.

c. Manufacturer and Model:

5. Pressure Gauge.

a. Each blower shall have pressure on the inlet and outlet, to provide for ease of operational verification.

b. Gauges shall be for applications involving vibration or pulsation.

c. Design Basis:

i.	Service:	Air
ii.	Type, Outlet Gauge:	Pressure
iii.	Range:	0-30 psi
iv.	Material of Construction (body):	Stainless Steel
v.	Filling:	Glucerin
vi.	Weight each:	6.17 lbs.

d. Manufacturer and Model: McDaniel 2 ½ "

6. Check Valve.

a. Each blower shall have a check valve on the outlet, to prevent air or water returning back into the blower.

b. Design Basis:

i.	Service:	Screened Partially Wastewater
ii.	Type:	Spring
iii.	Pressure Rating:	230 PSI
iv.	Material of Construction (body):	Stainless Steel
v.	Material of Construction (o-rings):	EPDM
vi.	Weight each:	6.2 lbs.

c. Manufacturer and Model:

7. Branch Isolation Valve.

a. The air header shall have branches to feed off-board zones. Each branch will have an isolation valve.

b. Valves shall be full port ball valves.

c. Design Basis:

i.	Service:	Permeate
ii.	Type:	Full Port Ball Valve

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iii. Pressure Rating: 2,000 PSI
iv. Material of Construction (body): 316 Stainless Steel
v. Material of Construction (seats): PTFE-TFM
vi. Weight each: 6.17 lbs.

d. Manufacturer and Model: Sharpe 12-6-6-050-DA

J. ANALYTICS

1. General.

a. Analytics will provide system measurements used for operational control and adjustments.

b. Unless otherwise noted as off-board, subsystem components shall be factory installed, pre-plumbed and pre-wired.

c. Subsystem controls will be integrated into the PLC and SCADA within the MBR system Panel.

2. Turbidity Meter.

a. The turbidity meter shall be provided for membrane integrity and effluent quality monitoring.

b. Sensor.

i. Measures turbidity to effectively monitor the quality filtered water.

ii. Design Basis:

a) Service: Permeate
b) Type: Scattered Light
c) Area Classification: Class 1, Division 2
d) Local Display: On Controller
e) Flow Rate Sample: 3 to 15.6 gph
f) Measurement Range: 0 to 1,000 NTU
g) Accuracy: ± 0.008 NTU ± 1% of Reading
h) Ambient Temperature: 36 to 104°F
i) Sample Temperature Maximum: 50°C
j) Supply Voltage: 24VAC
k) Weight: 3.3 lbs.

iii. Manufacturer and Model: HACH UltraTurb plus SC Sensor

c. Controller.

i. Multi-channel controller that operates one or two sensors.

ii. One controller may be combined with additional types of analytic sensors.

iii. Design Basis:

a) Service: Permeate
b) Type: Digital Controller
c) Area Classification: Class 1, Division 2

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d)	Local Display:	Yes, 160 x 240 pixels
e)	Sensor Inputs:	0.05 to 0.26 gpm
f)	Measurement Range:	0 to 1,000 NTU
g)	Accuracy:	± 0.008 NTU ± 1% of Reading
h)	Input/Output:	4-20 mA
i)	Digital Communication:	MODBUS 232/485 Profibus DP V1.0
j)	Ambient Temperature:	36 to 104°F
k)	Sample Temperature Maximum:	50°C
l)	Weight:	3.3 lbs.

iv. Manufacturer and Model: HACH sc200™

d. Sampling Pump.

i. The sample pump continuously pulls permeate from the OMU and delivers it to the sensor for measurement before returning the sample into Zone 1 for disposal.

ii. The sample pump must be self-priming and variable speed adjustable.

iii. The sample pump may be combined with the DO measurement.

iv. Design Basis:

a)	Service:	Permeate
b)	Type:	Peristaltic, Analog Speed Control
c)	Tube Material:	Norprene
d)	Area Classification Rating:	Class 1, Division 2
e)	Ratings:	NSF, CE, ETL
f)	Motor Duty:	Continuous
g)	Flow Range:	0 to 3.96 gph
h)	Suction Lift:	30’ Water 0 psig
i)	Maximum Solids:	50% by Volume
j)	Maximum Viscosity:	5,000 Centipoise
k)	Ambient Temperature:	14 to 110°F
l)	Fluid Temperature Maximum:	130°F
m)	Motor Voltage:	120VAC/31PH/60Hz
n)	Weight each:	12 lbs.

v. Manufacturer and Model: Blue White AN130F7T

e. Sampling Pump.

i. The sample pump continuously pulls permeate from the OMU and delivers it to the sensor for measurement before returning the sample into Zone 1 for disposal.

ii. The sample pump must be self-priming and variable speed adjustable.

iii. The sample pump may be combined with the DO measurement.

iv. Design Basis:

a)	Service:	Permeate
b)	Type:	Peristaltic, Analog Speed Control
c)	Tube Material:	Norprene
d)	Area Classification Rating:	Class 1, Division 2
e)	Ratings:	NSF, CE, ETL

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f)	Motor Duty:	Continuous
g)	Flow Range:	0 to 3.96 gph
h)	Suction Lift:	30' Water 0 psig
i)	Maximum Solids:	50% by Volume
j)	Maximum Viscosity:	5,000 Centipoise
k)	Ambient Temperature:	14 to 110°F
l)	Fluid Temperature Maximum:	130° F
m)	Motor Voltage:	120VAC/31PH/60Hz
n)	Weight each:	12 lbs.

v. Manufacturer and Model: Blue White AN130F7T

f. Flow Cell.

i. The flow cell is used to house the LDO probe. The sample pump will continuously deliver permeate to the flow cell so that constant measurements are taken.

ii. The flow cell shall be a clear body with a removable cover for quick inspection and to keep out sun light in the cell during operation.

iii. Design Basis:

a)	Service:	Permeate
b)	Type:	Clear Cylinder
c)	Maximum flow rate:	2 gpm
d)	Temperature:	32 to 104°F
e)	Maximum Pressure:	30 psig

iv. Manufacturer and Model: HACH LDO Flow Cell 7300800

3. Dissolved Oxygen (DO).

a. DO measurement shall be sampled continuously in the PA basin.

b. Probe.

i. Effectively monitors DO in the water sampled.

ii. Design Basis:

a)	Service:	Permeate
b)	Type:	Luminescent
c)	Area Classification:	Class 1, Division 2
d)	Local Display:	On Controller
e)	Flow Rate Sample:	3.96 gph
f)	Measurement Range:	0 to 20 mg/L
g)	Response Time:	95% < 60 sec @ 20°C
h)	Accuracy:	±0.1 mg/L Below 5 mg/L | ±0.2 Above 5 mg/L
i)	Operating Temperature:	32 to 122°F
j)	Supply Voltage:	24VAC
k)	Weight:	2.2 lbs.

iii. Manufacturer and Model: HACH LDO® Probe, Model 2 9020000

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c. Controller.

i. Multi-channel controller that operates one or two sensors.

ii. One controller may be combined with additional types of analytic probes or sensors.

iii. Design Basis:

a)	Service:	Permeate
b)	Type:	Digital Controller
c)	Area Classification:	Class 1, Division 2
d)	Local Display:	Yes, 160 x 240 pixels
e)	Sensor Inputs:	0.05 to 0.26 gpm
f)	Measurement Range:	0 to 1,000 NTU
g)	Accuracy:	± 0.008 NTU ± 1% of Reading
h)	Input/Output:	4-20 mA
i)	Digital Communication:	MODBUS 232/485 Profibus DP V1.0
j)	Ambient Temperature:	36 to 104° F
k)	Sample Temperature Maximum:	50°C
l)	Weight:	3.3 lbs.

iv. Manufacturer and Model: HACH sc200™

4. Total Suspended Solids (TSS).

a. Not Required

5. Influent BOD, TSS, TKN, NH3 and NO3 Monitoring System.

a. Not Required

6. Effluent BOD, TSS, TKN, NH3, NO3 and EColi Monitoring System.

a. Not Required

K. CHEMICAL ADDITION SYSTEMS

1. General.

a. Chemical addition is required to enhance the production, biological process, capacity or efficiency of the MBR system.

b. Unless otherwise noted as off-board, subsystem components shall be factory installed, pre-plumbed and pre-wired

c. Subsystem controls will be integrated into the PLC and SCADA within the MBR system Panel.

d. Dosing Pump.

i. The pump shall dose carbon as required to the designated zone show on the project PIDs.

ii. The dosing pump must be self-priming and variable speed adjustable.

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iii. Design Basis:

a)	Service:	Chemical Dosing
b)	Type:	Peristaltic, Analog Speed Control
c)	Dosing Material:	Various
d)	Tube Material:	Norprene
e)	Area Classification Rating:	Class 1, Division 2
f)	Ratings:	NSF, CE, ETL
g)	Motor Duty:	Continuous
h)	Flow Range:	0 to 3.96 gph
i)	Suction Lift:	30' Water 0 psig
j)	Maximum Solids:	50% by Volume
k)	Maximum Viscosity:	5,000 Centipoise
l)	Ambient Temperature:	14 to 110°F
m)	Fluid Temperature Maximum:	130°F
n)	Motor Voltage:	120VAC/31PH/60Hz
o)	Weight each:	12 lbs.

iv. Manufacturer and Model: Blue White AN130F7T

L. OPTIONS

1. Covers

a. Not Required.

2. Walkway.

a. Walkways provide additional access to zones and equipment.

b. Handrails shall be provided in areas that are elevated.

c. Design Basis

i.	Type:	Grating
ii.	Material of Construction (Panel):	Aluminum
iii.	Material Of Constuction (Rail):	Aluminum
iv.	Dead Load of Panel:	3.73 PSF
v.	Roof Live Load:	20.00 PSF
vi.	Vacuum Load:	0.0PSF
vii.	Concentrated Load:	300 LBF
viii.	Wind Speed:	100 MPH @ 3 second gust
ix.	Wind Importance Factor:	1.15
x.	Wind Exposure:	C

d. Manufacturer and Model: Ovivo

3. 316 Fasteners.

a. Not Required.

4. Heat Tracing.

a. Not Required.

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5. Remote Disconnect.

   a. Not Required.

   b. Remote disconnects provide local shut off to equipment.

   c. Disconnects will be integrated into the motor controls within the MBR system Panel.

6. Stairs.

   a. Stairs shall provide access to upper equipment porches.

   b. Handrails shall be provided in areas that are elevated.

   c. Design Basis:

i.	Type:	Grating
ii.	Material of Construction (Panel):	Aluminum
iii.	Material Of Constuction (Rail):	Aluminum
iv.	Dead Load of Panel:	3.73 PSF
v.	Live Load:	20.00 PSF
vi.	Concentrated Load:	300 LBF
vii.	Wind Speed:	100 MPH @ 3 second gust
viii.	Wind Importance Factor:	1.15
ix.	Wind Exposure:	C
x.	Weight per panel:	XX lbs.

   d. Manufacturer and Model: Ovivo

2.04 GENERAL FABRICATION REQUIREMENTS

The requirements listed below are in addition to those called out in the other sections. The MBR System includes all necessary subsystems to form a complete functional wastewater treatment plant. Subsystems are designed in accordance with the functional requirements described herein.

A. STEEL TANK AND EQUIPMENT PORCHES

1. Design

   a. Tanks shall be designed to support all hydrostatic, equipment, wind, live, and seismic loads as indicated on the drawings and in this specification.

   b. The system design shall comply with the following structural criteria:

      i. Maximum stresses on all tank components (walls, beams, tubing, etc.) shall not exceed 60% of yield.

      ii. Maximum allowable deflection of any single member: 1/2”

   c. Tank design shall include an anchoring system as necessary to meet wind and seismic resistance requirements as defined in state codes.

   d. Tank design shall provide lifting lugs.

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e. Maximum width shall be no more than 8.5 feet (excluding any removable sections).

f. Maximum height shall be no more than 12 feet (excluding any removable covers).

g. Tank system shall include integral equipment porches containing all pumps and blowers and associated piping, instrumentation, electrical cabinets/disconnects, and control panels. Porches shall have hand railings as required by code.

h. Tank system shall include access stairs or ladders to facilitate maintenance of the process and process equipment

2. Materials

a. Plates, Angles, and Channel Shapes:

i. Carbon steel plates, angles and shapes shall conform to the requirements of ASTM A-36 with a minimum yield strength of 36,000 psi.

ii. Wall floor and wall plates shall be ¼" thickness.

iii. Aluminum plates, angles and shapes shall be 6061 alloy with a T6 temper.

b. Carbon Steel Pipe: Carbon steel pipe shall conform to the requirements of ASTM A-53, type S, Grade B and ASME B16.10, schedule 40.

c. Stainless Steel Pipe: Stainless steel pipe shall conform to the requirements of ASTM A-312, TP304 and ASME B36.19, schedule 10 or 40, as specified in tank drawing nozzle schedule.

d. Unistrut: Unistrut structural members shall be P1000, 1 5/8", stainless steel.

3. Fabrication.

a. Tank welding shall conform to the requirement of ANSI/AWWA D-100-05: Welded Carbon Steel Tanks for Water Storage.

b. Tank welding shall conform to the requirement of ANSI/AWWA D-100-05: Welded Stainless Steel Tanks for Water Storage.

c. All welds shall be continuous seal welds.

d. Tank construction shall conform to applicable sections of AISC, 13th Edition of the Steel Construction Manual.

4. Piping.

a. All MBR System air scour piping shall be Type 304 stainless steel.

b. Permeate piping shall be schedule 80 PVC.

c. Piping shall have welded, glued, flanged, or mechanical groove (Victaulic) connections.

d. Pipe supports shall be 304 stainless steel Unistrut (or equivalent) systems or 304 stainless steel angle and structural shapes with stainless hardware, clamps, and guides.

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e. Transitions from MBR Supplier piping to Contractor's piping shall use ANSI 150 pound flat face flanges unless otherwise noted or coordinated with the Contractor.

5. Finishes, Carbon Steel Tanks

a. All internal and external carbon steel surfaces shall be painted.

b. All stainless steel surfaces and piping shall be painted.

c. Internal

i. Preparation: Prepare internal tank surfaces to a near white metal blast of 3 mil profile per SSPC-SP10, free of all visible oil, grease, dirt, dust, mill scale, rust, paint, oxides, corrosion products, and other foreign matter.

ii. Application: Apply interior paint in one coat to a 10-14 mils DFT thickness. Deposit by stripe coat on inside and outside corners followed by an immediate full coat application. Material should be brushed into cavities behind pipe penetration flanges as part of the stripe coat process. Observe all coating manufacture's requirements for application (pot life and recoat times).

iii. Paint shall be Carboline Liner 341.

d. External.

i. Preparation: Prepare internal tank surfaces and equipment porches to a near white metal blast of 3 mil profile per SSPC-SP10, free of all visible oil, grease, dirt, dust, mill scale, rust, paint, oxides, corrosion products, and other foreign matter.

ii. Application: Apply exterior epoxy primer paint at 3-6 mils DFT in one coat. The underside of the tank shall be treated as the exposed sides. Apply top-coat of polyurethane paint @ 2-3 mils thickness. Observe all coating manufacture's requirements for application (pot life and recoat times).

iii. Epoxy Primer Paint shall be Carboline Carboguard 893. Top-coat shall be polyurethane Carboline Carbothane 134.

e. Finish Color.

i. Standard

a) Carboline Gull Grey 2713 shall be used on all corrugated surfaces.

b) Carboline Light Grey C705 on all non-corrugated surfaces.

ii. Forest

a) Carboline Hunter Green 4372 shall be used on all corrugated surfaces.

b) Carboline Constitution 7801 on all non-corrugated surfaces.

iii. Desert

a) Carboline Parchment 5803 shall be used on all corrugated surfaces.

b) Carboline Eggshell 3848 on all non-corrugated surfaces.

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iv. Beach

a) Carboline New Leaf K349 shall be used on all corrugated surfaces.

b) Carboline Cirrus Cloud G186 on all non-corrugated surfaces.

f. Inspection and Testing.

i. 100% visual inspection shall be performed to insure that there are no runs, sags, blisters, voids or any other irregularities.

ii. Dry Film Thickness (DFT) testing shall be performed in accordance with SSPC PA 2, with the exception of the number of test "Spots". One (1) spot, consisting of three (3) readings shall be taken per every Five (5) square feet of surface.

iii. Holiday detection shall be performed in accordance with NACE RP 0188-99. A low voltage DC current at 67 ½ volts wet sponge shall be used.

B. COMPOSITE FIBERGLASS TANK

1. Design

a. Tanks shall be designed to support all hydrostatic, equipment, wind, live, and seismic loads as indicated on the drawings and in this specification.

b. The system design shall comply with the following structural criteria:

i. Tank design shall include an anchoring system as necessary to meet wind and seismic resistance requirements as defined in state codes.

ii. The tank shall withstand either a buried or above ground installation.

iii. Walls shall be a minimum of 4" thick.

iv.

v. Penetrations and nozzels shall be molded into the tank.

c. Tank design shall provide lifting lugs.

d. Dimensions shall be a maximum:

i. Width shall be no more than 10 feet.

ii. Length shall be no more than 50 feet (excluding any removable sections).

iii. Height shall be no more than 11 feet (excluding any removable sections).

e. Tank system shall include equipment and associated piping, instrumentation, and electrical boxes/disconnects.

f. Tank system shall include access walkways, stairs or ladders to facilitate maintenance of the process and process equipment. Elevated walkways shall have hand railings as required by code.

2. Materials

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a. Structure

i. Fiberglass reinforced polymer

ii. Foam Core

3. Fabrication.

a. Single-piece molded using vacuum infusion

b. Foam Core with R24 or more insulation rating.

4. Piping.

a. All MBR System air scour piping shall be Type 304 stainless steel.

b. Permeate piping shall be schedule 80 PVC.

c. Piping shall have welded, glued, flanged, or mechanical groove (Victaulic) connections.

d. Pipe supports shall be 304 stainless steel Unistrut (or equivalent) systems or 304 stainless steel angle and structural shapes with stainless hardware, clamps, and guides.

e. Transitions from MBR Supplier piping to Contractor's piping shall use ANSI 150 pound flat face flanges unless otherwise noted or coordinated with the Contractor.

5. Finishes

a. All internal and external surfaces shall be gel-coated

b. Finish Color.

i. Standard

a) Grey

c. Inspection and Testing.

i. 100% visual inspection shall be performed to insure that there are no runs, sags, blisters, voids or any other irregularities.

PART 3 PROJECT DELIVERY

3.01 PROJECT EXECUTION

A. Unless otherwise required in the Contract Documents, the MBR Supplier shall provide all submittal documentation as described in this Section no later than 3 weeks after receipt of purchase order and notice to proceed.

B. Unless otherwise required in the Contract Documents, the MBR Supplier shall ship all components in their Scope of Supply, as described in this Section, no later than 12 weeks for the microBLOX tank and 20 weeks for the PA tank after receipt of written submittal approval.

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3.02 COMPLETE SYSTEM FACTORY ACCEPTANCE TEST

A. Prior to shipment, the MBR System Supplier shall coordinate and conduct a system factory acceptance test (FAT) of the MBR section which will include:

1. The PLC control logic and HMI operability shall be demonstrated by systematically forcing I/O to verify all controls functions and HMI screen representations defined in the system control narrative

2. The MBR control panel shall be inspected for completeness, integrity and workmanship.

3. The system shall be completely connected including ancillary equipment, all interconnecting piping, interconnecting electrical and interconnecting communications. Wet test of the system with a complete hydraulic run through demonstrating the functionality of all pumping and blower subsystems shall be performed.

4. The MBR System Supplier shall furnish all materials, instruments, and incidental and expendable equipment required for Acceptance Testing of the Goods, except where otherwise specified.

5. The Owner or an authorized representative of the Owner may be present to witness the Acceptance Testing.

6. The MBR System Supplier shall keep detailed notes regarding the FAT and record all test data and results. Upon successful completion of the Acceptance Testing, the Supplier shall submit a written report on the FAT.

B. Prior to shipment, the MBR System Supplier shall coordinate a two (2) day pre-training session of the MBR System after completion of the FAT which will include:

1. A combination of classroom and hands-on training. All training shall be conducted at the supplier's location.

2. The required materials, texts, and supplies.

3. Video recording by the MBR System Supplier which will be edited for inclusion into the digital operations tablet.

4. Equipment Operation:

   a. Describe equipment operating (process) function.

   b. Describe equipment's fundamental operating principles.

   c. Identify equipment's mechanical, electrical, and electronic components and features.

   d. Identify all support equipment associated with the operation of subject equipment.

   e. Recommend standard operating procedures to address start-up, routine monitoring, and shut-down of the equipment.

5. Detailed Component Description:

   a. Identify and describe in detail each component's function.

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b. Group related components into subsystems, where applicable. Describe subsystem functions and their interaction with other subsystems

c. Identify and describe in detail equipment safeties and control interlocks

6. Equipment Preventive Maintenance (PM):

a. Describe PM inspection procedures required to:

i Perform an inspection of the equipment in operation.

ii Spot potential trouble symptoms and anticipate breakdowns.

iii Forecast maintenance requirements (predictive maintenance).

b. Define the recommended PM intervals for each component.

c. Provide lubricant and replacement part recommendations and limitations.

d. Describe appropriate cleaning practices and recommend intervals.

e. Identify and describe the use of special tools required for maintenance of the equipment.

f. Describe component removal/installation and disassembly/assembly procedures.

g. Perform "hands-on" demonstrations of preventive maintenance procedures.

h. Describe recommended measuring instruments and procedures, and provide instruction on interpreting alignment measurements, as appropriate.

i. Define recommended torque, mounting, calibration, and/or alignment procedures and settings, as appropriate.

j. Describe recommended procedures to check/test equipment following a corrective repair.

7. Equipment trouble shooting;

a. Define recommended systematic troubleshooting procedures.

b. Provide component specific troubleshooting checklists.

c. Describe applicable equipment testing and diagnostic procedures to facilitate troubleshooting.

8. Control System. Training is to include:

a. Navigation of all HMI screens and menus.

b. Review of automatic operations and controls.

c. Changing process set points.

d. Overriding controls from the HMI.

e. Manual operation of the system in the event of a power failure.

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f. Trouble shooting.

3.03 MATERIALS INSPECTION

A. The Contractor shall inspect delivered equipment upon arrival on site for completeness of scope delivery and to verify that all components have arrived undamaged. The Contractor is responsible for notifying the Supplier of deficiencies in quantities or conditions within 28 days from the ship date.

B. The Contractor shall provide all labor, materials, and equipment for unloading, de-crating, organizing, and compiling take-off of received MBR equipment, components, and instrumentation.

C. The Supplier shall make available, upon the request of the Contractor, personnel to assist in the inspection of the Supplier's equipment upon unload at the site. Supplier's personnel shall provide services in accordance with their standard daily rates.

3.04 SYSTEM COMMISSIONING

A. The MBR System Supplier shall coordinate with the Contractor, Engineer, and Owner for execution of the System Commissioning. In advance of System Commissioning the MBR System Supplier shall perform an onsite Mechanical Inspection of the facility and generate a punchlist of inconsistencies. The Contractor is required to resolve the punchlist items to the satisfaction of the System Supplier, prior to scheduling System Commissioning.

B. The MBR System Supplier shall prepare a "Detailed Plan of Commissioning Activities" that will be used as a guideline for Commissioning of the Goods provided by the Supplier. The Detailed Plan of Commissioning Activities shall be used to coordinate the activities of the Supplier's and Owner's personnel. The "Detailed Plan of Commissioning Activities" will identify the Commissioning requirements for all Goods supplied by the MBR System Supplier. The guidelines shall include the following:

1. General inspection of systems (lubrication, rotation, calibration).

2. Loop checking, instrumentation, and control system verification.

3. Pipe loss testing.

4. Clean water permeability testing.

5. Sludge seeding.

6. Biological process system.

7. Chemical feed systems and Clean-in-Place.

8. Commissioning of equipment.

9. Start-up activities.

   a. Feed, Filtered Water and Backwash Flow Pressure and Level Control Sequences.

   b. Membrane Treatment Unit Operations including filtration, relaxation, backwashing, and clean in place.

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c. Normal and Emergency Start Up and Shut Down Sequences.

d. Process Interlocks

10. Training

C. Failure to complete the Commissioning as required by this Section within the allocated time shall constitute a failure of the MBR System Supplier to provide Special Services in accordance with the requirements of the Contract..

D. The Contractor shall provide materials and personnel in support of the System Commissioning to fill tanks with clean water, transfer fluids, repair/remedy any and all electrical and mechanical issues, provide temporary tie-ins, temporary piping, transfer pumps, etc.

E. The Contractor shall coordinate with the Engineer and Owner to seed the MBR system with sludge at the conclusion of the clean water testing. The MBR Supplier is not responsible for supplying the seed sludge.

F. The System Commissioning shall begin at the Contractor's discretion, within the limits defined herein:

1. Successful completion of a pre-commissioning Mechanical Inspection is required.

2. Start of Commissioning shall be no later than 30 days after completion of Mechanical Inspection.

G. The Owner shall operate the plant during the Commissioning Period; however, Supplier and Contractor shall be allowed to provide onsite assistance.

H. Supplier is responsible for monitoring operating conditions and performance during the Commissioning Period.

I. The MBR Supplier shall place the Goods into operation and perform tests to determine if equipment is operating properly. The purpose of these tests is to verify that both the System and each Unit are:

1. Properly installed.

2. Operational.

3. Capable of completing an operating cycle free of problems.

4. Free from pump or valve cavitation, water hammer, overheating, overloading, vibration, or other operating problems

5. The MBR System Supplier shall verify that control programming has been configured with appropriate software time delays to avoid rapid pump or membrane flow cycling in response to transient dynamic hydraulic effects caused by backwash, or chemical washing cycles or other process cycles (e.g. start -up, shut down, membrane test). "Dead-heading" or any operation of any pump under a "zero-flow" or "flow condition below the pump manufacturers acceptable limits" is not acceptable. Interlocks shall be provided to prevent operation of the any pump under a "dead- headed" condition. The pump manufacturers recommended "maximum number of pumps starts per hour" shall not be exceeded.

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J. As a part of commissioning, the MBR System Supplier shall start-up and operate all support systems provided by or required by the Supplier for operation of the system, including but not limited to chemical feed systems, instrumentation, air compression equipment, and electric controls. This testing shall demonstrate that there are no water or air leaks in the system, that the piping has been installed and connected properly, that the electrical system is operating correctly, and that the instrumentation has been properly calibrated.

K. The MBR System Supplier shall furnish materials (excluding chemicals and power), instruments, and incidental and expendable equipment required for commissioning/placing the Goods into operation. The Supplier shall retain the services of any manufacturer's representatives as required in the Contract Documents to assist with commissioning/placing into operation of the Goods. The costs of these services shall be borne by the MBR System Supplier.

L. Membrane permeate quality shall be evaluated to determine compliance of the MBR System with Performance Requirements. If the MBR system fails to comply with requirements of membrane permeate quality, Supplier shall provide the Owner and the Engineer a written plan of recommended modifications to the system (such as repairing damaged fibers, replacing seals, complete replacement of system) to achieve compliance with the requirements. Upon implementation of modifications plan, the permeate quality tests shall re-commence in their entirety.

M. When requested by the MBR System Supplier, the Engineer shall review the operation of the equipment to verify that the commissioning is complete.

1. The Engineer shall perform random tests on equipment and witness various operational sequences to confirm general conformance to the Contract Documents

2. The Engineer shall initiate alarm conditions and perform random tests on the control system to confirm general conformance to the Contract Documents.

3. The Engineers review shall include a review of the HMI interface and PLC SCADA system commissioning requirements to determine conformance with the Equipment specifications and requirements of the Project. The Engineers review shall identify any equipment that has not been properly installed, or operating, detailing the outstanding installation issues on a "punch list" and noting the party who shall be responsible for each correction and identify the items require that correction.

4. Upon satisfactory completion of the review, the Engineer shall submit to the MFEM a written "Notice of Completed Commissioning"

N. Once the "Notice of Completed Commissioning" is issued, Training of Operation and Maintenance Personnel may commence.

3.05 TRAINING

A. The MBR System Supplier shall provide Training in the maintenance and operation of all systems included in the Supplier’s control system.

B. Failure to complete the Training as required by this Section within the allocated time shall constitute a failure of the MBR System Supplier to provide Special Services in accordance with the requirements of the Contract.

C. The Supplier shall provide formal training of the Owner's personnel. Training shall commence after the "Notice of Completed Commissioning" is issued.

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D. Training of the Owner's personnel shall commence within a period of five (5) days after the "Notice of Completed Commissioning" has been issued as mutually agreed to by the Owner, Engineer, Contractor and Supplier. All training shall be performed by the MBR System Supplier or a factory-certified representative of the supplier or component supplier. Training is to include:

1. Navigation of all HMI screens and menus.
2. Review of automatic operations and controls.
3. Changing process set points.
4. Overriding controls from the HMI.
5. Manual operation of the system in the event of a power failure.
6. Component equipment.
7. Instrument components.
8. Routine Maintenance.
9. Maintenance cleaning.
10. Biological process theory.
11. Biological processes.
12. Membrane filtration theory.
13. Daily, weekly and monthly checklists and reports.
14. Forecast maintenance requirements (predictive maintenance)
15. Trouble shooting.
16. Video of training & system operations.

E. The MBR System Supplier shall provide a combination of classroom and hands-on training. All training shall be conducted at the Owner's location.

1. The MBR System Supplier shall be responsible for all costs associated with training and shall provide required materials, texts, and supplies.
2. Training sessions shall be video recorded by the MBR System Supplier at the Supplier's expense.

F. The MBR System Supplier shall develop and submit to the Engineer and Owner a Training Manual. The Training Manual shall include the elements presented in this Section or as required by the MBR System Supplier or component equipment supplier.

1. The Supplier shall prepare a Training Lesson Plan, provide qualified instructors, and schedule the training in an organized manner.
2. Credentials for the MBR System Supplier’s designated instructor(s) shall be submitted thirty (30) days prior to the commencement of training. Credentials shall include a brief resume

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and specific details of the instructor(s) pertaining both to personal experience operating and maintaining the specified equipment and conducting operation and maintenance for the same equipment.

3. The Supplier's proposed lesson plans shall detail specific instruction topics. Training aids to be utilized in the instruction shall be referenced and attached where applicable to the proposed lesson plan. "Hands-on" demonstrations planned for the instruction shall be described in the lesson plan.

4. The Supplier shall indicate the estimated duration of each segment of the training in the lesson plan.

5. Submit information as required by the local primacy agency in support of Professional Development Hours.

3.06 DEMONSTRATION

A. The MBR System Supplier shall provide demonstration testing of the membrane bioreactor equipment.

B. Failure to complete the Demonstration as required by this Section within the allocated time shall constitute a failure of the MBR System Supplier to provide Special Services in accordance with the requirements of the Contract.

C. The demonstration shall commence after the "Notice of Completed Training" is issued.

D. Demonstration shall extend for a period of 60 days.

E. The Engineer shall document the time when the facilities are substantially unavailable for use by the MBR System Supplier to perform Demonstration Testing due to circumstances beyond the control of the Suppliers including but not limited to power outages, lack of feedwater, inability to transfer product water or feedwater due to factors beyond the control of the MBR System Supplier, not having adequate staff from the Contractor or the Owner. If in the sole opinion of the Engineer the facilities are substantially unavailable to the Supplier, equivalent additional Demonstration Testing time will be granted without penalty.

F. Upon completion of the Performance Testing, the MBR Supplier shall submit to the Owner a written report detailing the results of the Demonstration Testing. The report shall include, at a minimum, the following sections:

1. Introduction

2. Overview of demonstration testing procedures.

3. Summary of testing results.

4. Appendices that include a copy of all field notes and test data.

G. The purpose of the Demonstration Testing is to demonstrate that MFEM furnished equipment is:

1. Properly installed.

2. Ready to be placed into service by the Owner.

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3. In compliance with the service conditions, performance requirements, material specifications, and all other requirements of the Contract Documents.

H. The MBR System Supplier shall furnish all materials, instruments, and incidental and expendable equipment required for Acceptance Testing of the Goods, except where otherwise specified.

I. During the Demonstration period, the MBR SYSTEM SUPPLIER is solely responsible for identifying water quality parameters, instrumentation and control programming required to satisfy and maintain effluent requirements. The MBR SYSTEM SUPPLIER shall establish instrumentation alarm and shutdown limits to prevent operation of the equipment outside the established limits.

1. The Owner shall maintain a high speed connection to the processor but all data monitoring shall be the responsibility of the MBR SYSTEM SUPPLIER. The Owner shall not be required to monitor, report or record instrument field data for process warranty purposes.

J. Throughout the Demonstration period, a representative of the MFEM shall be available via means of cellular communication including non-working hours in case of an emergency.

K. The Owner or an authorized representative of the Owner will be present to witness the Performance Testing.

L. The Owner or an authorized representative of the Owner shall operate the plant as directed by the MBR System Supplier.

M. The MBR System Supplier shall keep detailed notes regarding the Performance Testing and record all test data and results. This will be done through operation of the data logging system.

N. If the System does not perform in accordance with the Contract Documents, the Supplier shall return or remain on site to perform all necessary corrections at the cost of the MBR System Supplier until compliance with Contract Documents is demonstrated.

O. During the Demonstration period, the System shall perform in accordance with the guaranteed product water quality to allow the Owner to discharge treated water.

P. Any interruption of the Performance Testing caused by circumstances beyond the control of the MBR System Supplier shall not require the testing to be restarted from the beginning. Such events include any activities that would result in an inadvertent or unplanned shutdown of the PLC / HMI control System or otherwise interfere with the Performance Test. The elapsed time of Performance Testing prior to the interruption will be applied to the required testing period.

3.07 DIGITAL OPERATIONS

A. A tablet shall be provided for digital interface. The digital tablet shall be enabled for wireless connectivity through the Control Panel.

B. The tablet shall be configured as follows:

1. Screen shall have a minimum 9.4 inch x 6.6 inch display with 2048 c 1536 screen resolution.

2. Multi-touch display.

3. 64 GB storage capacity.

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4. A8X chip with 64-bit architecture.

5. Wireless: Wi-Fi (802.11a/b/g/n); dual channel (2.4 GHz and 5 GHz); and cellular connection for carriers AT&T, Verizon, Sprint and T Mobile.

6. Minimum 1.2 megapixel HD front and 720p HD video Minimum 8.0 megapixel rear camera with f/2.4 aperture, and video 1080p HD recording.

7. Bluetooth 4.0.

8. Sensors – Three axis gyro and accelerometer.

9. Up to 10 hours built in battery time.

10. Accessories shall include:

    a. Military grade cover and shoulder strap

    b. Manufacturer & Model: Apple iPAD Air 2, 64GB with WiFi and cellular

C. Digital OPS shall include, with wireless access to:

1. Remote access to system HMI and SCADA with identical operator interface and functions as the on-board system.

2. A MBR System Supplier managed Web Portal for Customer access to asset management. The web portal shall include:

    a. Equipment Information.

    b. Contact information.

    c. Maintenance schedules.

    d. Parts ordering.

3. A weekly downloaded system status report that are archived by date and easily accessible containing:

    a. Daily average flow.

    b. Daily average flux.

    c. Daily average permeability.

    d. Daily average TMP.

    e. Daily average turbidity.

    f. Daily dissolved oxygen.

    g. Daily average total suspended solids.

    h. Alarms generated

    i. Organized for each parameter with the following:

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i. Data Table

ii. Dashboard

iii. Trend Chart

4. Digital interactive and searchable Operations and Maintenance manual shall include the following:

   a. Digital links within and between Drawings, PIDs and equipment data sheets.

   b. O&M with digital links between subsystems, control narrative, data sheets, trouble shooting guidelines, manufacturer service manuals.

   c. Operational Videos.

   d. Operation Forms

   e. Downloads of drawings, PIDs, manuals, data sheets and guidelines.

   f. Access to MBR System Supplier technical support website which contains the following:

      i. General technical memorandums.

      ii. MBR Forum.

      iii. Technical Papers.

      iv. Technical Support Blog

      v. Skype.

   g. Operator Apps to include:

      i. Microsoft Office Suite
      ii. Pen Ultimate
      iii. Good Reader
      iv. Drop Box
      v. Vibration / Sound Analyzer
      vi. Dirty Power Analyzer

END OF SECTION

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SECTION 46 23 66

GRIT DEWATERING CONTAINER

PART 1 – GENERAL

1.01 DESCRIPTION

Furnish all materials, equipment, and appurtenances required to provide a front loader style dewatering container with a 4 cubic yard capacity, as shown and specified.

1.02 QUALITY ASSURANCE

A. Prequalification Requirements:

Any alternate Dewatering Container manufacturer that is not named or listed as approved equal, must submit the following, 15 days prior to bid to be considered for approval:

1. To be considered, the manufacturer will be regularly engaged in the manufacture of grit dewatering containers.
2. The manufacturer will provide documentation of previous experience with municipal grit dewatering systems in wastewater applications.
3. Pre-qualification submittals from manufacturers will include a complete and detailed proposal of equipment offered, including a detailed description of any exceptions taken to the specification.

1.03 SUBMITALS

A. Shop Drawings:

Submit for review, shop drawings showing the following:

1. Complete description in sufficient detail to permit an item comparison with the specification.
2. Dimensions and installation requirements.
3. Descriptive information including catalogue cuts and manufacturer's specification for components.

1.04 GUARANTEE

A. Equipment:

The equipment furnished under this section will be free of defects in material and workmanship, including damages that may be incurred during shipping for a period of 12 months from date of substantial completion.

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PART 2––PRODUCTS

2.01 MANUFACTURER

A. Park USA, of Houston, Texas. To propose an alternate manufacturer, refer to the documentation requirements in 1.01 and 1.02 of this section. If other equipment is proposed, the Contractor must demonstrate to the Engineer and the Owner that all requirements of materials, validation, experience, performance, and workmanship have been met or exceeded by the equipment proposed. Contractors proposing alternate manufacturers will be responsible for all costs associated with system evaluation and redesign including all electrical, mechanical, and civil aspects of the installation.

2.02 GENERAL REQUIREMENTS

A. Provide a dewatering container, completed with filtration media, as shown on the Contract Drawings and as herein specified.

B. Dewatering system will be designed for complete outdoor installation.

2.03 DESIGN, CONSTRUCTION, AND MATERIALS

A: Container Body:

1. Container body is made of heavy gauge steel to withstand the stress of continued use.
2. The sides of the container shall be made of 10 gauge steel.
3. The bottom of the container shall be made of 7 gauge steel.
4. The container shall meet ANSI safety specifications and dimensional standards for haulers.
5. The container shall be designed to be handled by a standard garbage truck.
6. The container shall have 3-way flared fork pockets to easily guide forks into the pockets and protect the container from damage. The fork pockets will have taco gussets welded to the bottom to provide additional strength and protection. There shall be fully welded, no-step gusts across the tops of the fork pockets to provide safety and support.
7. The front of the container shall have rounded bumper pads.
8. The top edges of the container shall be rounded and smooth for added safety during customer loading.
9. The container shall have an interlocking top channel frame to provide added strength.
10. The floor channels shall extend up the front and back walls to create extra support and shall be capped at both ends to prevent debris from entering.
11. There shall be a continuous weld on all inside seams of the container body to provide protection against corrosion.
12. The container lids shall be single wall, double lip.
13. Drain ports shall be provided on each side bottom of the container body. They shall be a minimum of 2 inches with female threads and be equipped with male aluminum camlock fittings and watertight cam lock caps.

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B. Filter System:

1. The internal filter support structure shall be comprised of a ¼ inch angle iron frame that is continuously welded to the inside wall of the container at the locations where it touches that walls and floor. The frame shall stand away from the walls by 2 inches and from the floor by 3 inches to allow for free drainage of liquid from the filter cake.
2. Carbon steel perforated plate panels shall be fastened to the frame in order to support the filter media. The panels shall be ¼ inch thick with a hole-pattern of 3/8 inch holes on ½ inch centers.
3. The filter media shall be Park Process MS-7052 and shall have the following characteristics:
   a. Fiber: Polyester.
   b. Color: Green.
   c. Count: 64 X 24 per inch.
   d. Weave: 6 x 2 modified satin.
   e. Warp Diameter: 500 microns.
   f. Weft Diameter: 800 microns.
   g. Weight 39.9 ounces per square yard.
   h. Tensile Strength: 1650 pounds per inch.
   i. Air Permeability: 385 millimeters cubed/millimeters squared/second.
   j. Thickness: 0.083 inches.
   k. Micron Opening: 0 x 325.
   l. Micron Retention: 260.
   m. Open Area: 19%
4. The filter media shall be installed on the floor, both short walls and both long walls. The filter media shall rise to a height of 39 inches above the bottom floor filter.
5. Tie down brackets shall be made from ¼ inch thick flat bar.
6. Stainless steel tie down fasteners shall be used.
7. A sponge rubber (nitrile) gasket shall be installed between the support structure and the perforated plate panels to prevent solids from by-passing the filter media.
8. The perforated plate panels and tie down brackets shall be hot dip galvanized. All other carbon steel surfaces shall be sandblasted with a SSPC SP6 commercial blast, coated on the inside and outside with a two-part epoxy primer, and upper coated with urethane to a combined thickness of 6mls on the outside and 8 mls on the inside.

PART 3––EXECUTION

3.01 INSTALLATION

Install in accordance with drawings, shop drawings and manufacturer's instructions.

END OF SECTION