CONTRACT DOCUMENTS

FOR

CONSTRUCTION OF

WWTP IMPROVEMENTS

FOR

CITY OF SWEET HOME

JUNE 2020

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FOR
WWTP IMPROVEMENTS
FOR
CITY OF SWEET HOME

Division 34 through Division 39
NOT USED

Division 40 - Process Integration

END OF SECTION

SECTION 23 00 00 - HEATING, VENTILATING AND AIR CONDITIONING (HVAC) BASIC REQUIREMENTS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Work included in 23 00 00, HVAC Basic Requirements applies to Division 23, HVAC work to provide materials, labor, tools, permits, incidentals, and other services to provide and make ready for Owner's use of heating, ventilating and air conditioning systems for proposed project.

B. Contract Documents include, but are not limited to, Specifications including Division 00, Procurement and Contracting Requirements and Division 01, General Requirements, Drawings, Addenda, Owner/Architect Agreement, and Owner/Contractor Agreement. Confirm requirements before commencement of work.

C. Definitions:

1. Provide: To furnish and install, complete and ready for intended use.
2. Furnish: Supply and deliver to project site, ready for unpacking, assembly and installation.
3. Install: Includes unloading, unpacking, assembling, erecting, installation, applying, finishing, protecting, cleaning and similar operations at project site as required to complete items of work provided.
4. Approved or Approved Equivalent: To possess the same performance qualities and characteristics and fulfill the utilitarian function without any decrease in quality, durability or longevity. For equipment/products defined by the Contractor as "equivalent", substitution requests must be submitted to Engineer for consideration, in accordance with Division 01, General Requirements, and approved by the Engineer prior to submitting bids for substituted items.
5. Authority Having Jurisdiction (AHJ): Indicates reviewing authorities, including local fire marshal, Owner's insurance underwriter, Owner's Authorized Representative, and other reviewing entity whose approval is required to obtain systems acceptance.

1.2 RELATED SECTIONS

A. Contents of Section applies to Division 23, HVAC Contract Documents.

B. Related Work:

1. Additional conditions apply to this Division including, but not limited to:

    a. Specifications including Division 00, Procurement and Contracting Requirements and Division 01, General Requirements.

    b. Drawings

    c. Addenda

    d. Owner/Architect Agreement

    e. Owner/Contractor Agreement

    f. Codes, Standards, Public Ordinances and Permits

1.3 REFERENCES AND STANDARDS

A. References and Standards per Division 01, General Requirements, individual Division 23, HVAC Sections and those listed in this Section.

B. Codes to include latest adopted editions, including current amendments, supplements and local jurisdiction requirements in effect as of the date of the Contract Documents, of/from:

1. State of Oregon:

    a. OAR - Oregon Administrative Rules

    b. OESC - Oregon Electrical Specialty Code

    c. OFC - Oregon Fire Code

    d. OMSC - Oregon Mechanical Specialty Code

    e. OPSC - Oregon Plumbing Specialty Code

    f. OSSC - Oregon Structural Specialty Code

    g. OZERCC - Oregon Zero Energy Ready Commercial Code

    h. Oregon Elevator Specialty Code

C. Reference standards and guidelines include but are not limited to the latest adopted editions from:

1. ABA - Architectural Barriers Act

2. ABMA - American Bearing Manufacturers Association
3. ADA - Americans with Disabilities Act
4. AHRI - Air-Conditioning Heating & Refrigeration Institute
5. AMCA - Air Movement and Control Association
6. ANSI - American National Standards Institute
7. ASCE - American Society of Civil Engineers
8. ASHRAE - American Society of Heating, Refrigeration and Air-Conditioning Engineers
9. ASHRAE Guideline 0, The Commissioning Process
10. ASME - American Society of Mechanical Engineers
11. ASPE - American Society of Plumbing Engineers
12. ASSE - American Society of Sanitary Engineering
13. ASTM - ASTM International
14. AWWA - American Water Works Association
15. CFR - Code of Federal Regulations
16. CGA - Compressed Gas Association
17. CISPI - Cast Iron Soil Pipe Institute
18. EPA - Environmental Protection Agency
19. ETL - Electrical Testing Laboratories
20. FM - FM Global
21. GAMA - Gas Appliance Manufacturers Association
22. HI - Hydraulic Institute Standards
23. IAPMO - International Association of Plumbing & Mechanical Officials
24. IFGC - International Fuel Gas Code

25. ISO - International Organization for Standardization

26. MSS - Manufacturers Standardization Society

27. NEC - National Electric Code

28. NEMA - National Electrical Manufactures Association

29. NFPA - National Fire Protection Association

30. NFGC - National Fuel Gas Code

31. NRCA - National Roofing Contractors Association

32. NSF - National Sanitation Foundation

33. OSHA - Occupational Safety and Health Administration

34. SMACNA - Sheet Metal and Air Conditioning Contractors' National Association, Inc.

35. TEMA - Tubular Exchanger Manufactures Association

36. TIMA - Thermal Insulation Manufactures Association

37. UL - Underwriters Laboratories, Inc.

D. See Division 23, HVAC individual Sections for additional references.

1.4 SUBMITTALS

A. See Division 01, General Requirements for Submittal Procedures as well as specific individual Division 23, HVAC Sections.

B. Provide drawings in format and software release equal to the design documents. Drawings to be the same sheet size and scale as the Contract Documents.

C. In addition:

1. "No Exception Taken" constitutes that review is for general conformance with the design concept expressed in the Contract Documents for the limited purpose of checking for conformance with information given. Any action is subject to the requirements of the Contract Documents. Contractor is responsible for the dimensions and quantity and will confirm and correlate at the job site, fabrication processes and techniques of construction, coordination of the work with that of all other trades, and the satisfactory performance of the work.

2. Provide product submittals and shop drawings in electronic format only. Electronic format must be posted to ftp site. For electronic format, provide one file per division containing one bookmarked PDF file with each bookmark corresponding to each Specification Section. Arrange bookmarks in ascending order of Specification Section number. Individual submittals sent piecemeal in a per Specification Section method will be returned without review or comment. All transmissions/submissions to be submitted to Architect. At Contractor's option, four separate submittals may be provided, consisting of long lead items, underground/site work, building work, and building automation system. Deviations will be returned without review.

3. Product Data: Provide Manufacturer's descriptive literature for products specified in Division 23, HVAC Sections.

4. Identify/mark each submittal in detail. Note what differences, if any, exist between the submitted item and the specified item. Failure to identify the differences will be considered cause for disapproval. If differences are not identified and/or not discovered during the submittal review process, Contractor remains responsible for providing equipment and materials that meet the Specifications and Drawings.

    a. Label submittal to match numbering/references as shown in Contract Documents. Highlight and label applicable information to individual equipment or cross out/remove extraneous data not applicable to submitted model. Clearly note options and accessories to be provided, including field installed items. Highlight connections by/to other trades.

    b. Include technical data, installation instructions and dimensioned drawings for products, fixtures, equipment and devices installed, furnished or provided. Reference individual Division 23, HVAC Specification Sections for specific items required in product data submittal outside of these requirements.

    c. Provide pump curves, operation characteristics, capacities, ambient noise criteria, etc. for equipment.

    d. For vibration isolation of equipment, list make and model selected with operating load and deflection.

    e. See Division 23, HVAC individual Sections for additional submittal requirements outside of these requirements.

5. Maximum of two reviews of submittal package. Arrange for additional reviews and/or early review of long-lead items; Bear costs of these additional reviews at

Engineer's hourly rates. Incomplete submittal packages/submittals will be returned to contractor without review.

6. Resubmission Requirements: Make corrections or changes in submittals as required, and in consideration of Engineer’s comments. Identify Engineer’s comments and provide an individual response to each of the Engineer’s comments. Cloud changes in the submittals and further identify changes which are in response to Engineer’s comments.

7. Structural/Seismic: Provide weights, dimensions, mounting requirements and like information required for mounting, seismic bracing, and support. Indicate manufacturer's installation and support requirements to meet Section 23 05 48, Vibration and Seismic Controls for HVAC Equipment. Provide engineered seismic drawings and equipment seismic certification. Equipment Importance Factor as specified in Division 01 and in Structural documents.

8. Trade Coordination: Include physical characteristics, electrical characteristics, device layout plans, wiring diagrams, and connections as required by Division 23, HVAC Coordination Documents. For equipment with electrical connections, furnish copy of approved submittal for inclusion in Division 26, Electrical submittals.

9. Make provisions for openings in building for admittance of equipment prior to start of construction or ordering of equipment.

10. Substitutions and Variation from Basis of Design:

    a. The Basis of Design designated product establishes the qualities and characteristics for the evaluation of any comparable products by other listed acceptable manufacturers if included in this Specification or included in an approved Substitution Request as judged by the Design Professional.

    b. If substitutions and/or equivalent equipment/products are being proposed, it is the responsibility of parties concerned, involved in, and furnishing the substitute and/or equivalent equipment to verify and compare the characteristics and requirements of that furnished to that specified and/or shown. If greater capacity and/or more materials and/or more labor is required for the rough-in, circuitry or connections than for the item specified and provided for, then provide compensation for additional charges required for the proper rough-in, circuitry and connections for the equipment being furnished. No additional charges above the Base Bid, including resulting charges for work performed under other Divisions, will be allowed for such revisions. Coordinate with the requirements of "Submittals". For any product marked "or approved equivalent", a substitution request must be submitted to Engineer for approval prior to purchase, delivery or installation.

11. Shop Drawings: Provide coordinated shop drawings which include physical characteristics of all systems, equipment, ductwork and piping layout plans, and control wiring diagrams. Reference individual Division 23, HVAC Specification Sections for additional requirements for shop drawings outside of these requirements.

    a. Provide Shop Drawings indicating access panel locations for items that require Code or maintenance access, size and elevation for approval prior to installation.

12. Samples: Provide samples when requested by individual Sections.

13. Resubmission Requirements:

    a. Make any corrections or change in submittals when required. Provide submittals as specified. The engineer will not be required to edit and/or interpret the Contractor's submittals. Indicate changes for the resubmittal in a cover letter with reference to page(s) changed and reference response to comment. Cloud changes in the submittals.

        1) Resubmit for review until review indicates no exception taken or make "corrections as noted".

        2) When submitting drawings for Engineers re-review, clearly indicate changes on drawings and "cloud" any revisions. Submit a list describing each change.

14. Operation and Maintenance Manuals, Owner's Instructions:

    a. Submit, at one time, electronic files (PDF format) of manufacturer's operation and maintenance instruction manuals and parts lists for equipment or items requiring servicing. Include valve charts. Submit data when work is substantially complete and in same order format as submittals. Include name and location of source parts and service for each piece of equipment.

        1) Include copy of approved submittal data along with submittal review letters received from Engineer. Data to clearly indicate installed equipment model numbers. Delete or cross out data pertaining to other equipment not specific to this project.

        2) Include copy of manufacturer's standard Operations and Maintenance for equipment. At front of each tab, provide routine maintenance documentation for scheduled equipment. Include manufacturer's recommended maintenance schedule and highlight maintenance

required to maintain warranty. Furnish list of routine maintenance parts, including part numbers, sizes, quantities, relevant to each piece of equipment: belts, motors, lubricants, and filters.

3) Include Warranty per Division 00, Procurement and Contracting Requirements and Division 01, General Requirements, Section 23 00 00, HVAC Basic Requirements and individual Sections.

4) Include product certificates of warranties and guarantees.

5) Include copy of complete parts list for equipment. Include available exploded views of assemblies and sub assemblies.

6) Include copy of startup and test reports specific to each piece of equipment.

7) Include copy of final air and water systems balancing log along with pump, fan and distribution system operating data.

8) Include commissioning reports.

9) Include copy of valve charts/schedules.

10) Engineer will return incomplete documentation without review. Engineer will provide one set of review comments in Submittal Review format. Contractor must arrange for additional reviews; Contractor to bear costs for additional reviews at Engineer's hourly rates.

b. Thoroughly instruct Owner in proper operation of equipment and systems. Where noted in individual Sections, training will include classroom instruction with applicable training aids and systems demonstrations. Field instruction per Section 23 00 00, HVAC Basic Requirements Article titled "Demonstration".

c. Copies of certificates of code authority inspections, acceptance, code required acceptance tests, letter of conformance and other special guarantees, certificates of warranties, specified elsewhere or indicated on Drawings.

15. Record Drawings:

a. Maintain at site at least one set of drawings for recording “As-constructed” conditions. Indicate on drawings changes to original documents by referencing revision document, and include buried elements, location of cleanouts, and location of concealed mechanical items. Include items changed by field orders, supplemental instructions, and constructed conditions.

b. Record Drawings are to include equipment and fixture/connection schedules, control dampers, fire smoke dampers, fire dampers, valves, bottom of pipe, duct and equipment elevations and dimensioned locations for all distribution systems (hydronic and air). Invert elevations and dimensioned locations for underground systems below grade to 5-feet outside building that accurately reflect "as constructed or installed" for project.

c. At completion of project, input changes to original project Revit Model and make one set of black-line drawings created from Revit Model in version/release equal to contract drawings. Submit Revit disk and drawings upon substantial completion.

d. At completion of project, show changes and deviations from the Drawings in red on one set of black-line drawings. Include written Addendums, RFIs, and change order items. Make changes to Drawings in a neat, clean, and legible manner.

e. See Division 23, HVAC individual Sections for additional items to include in record drawings.

1.5 QUALITY ASSURANCE

A. Regulatory Requirements: Work and materials installed to conform with all local, State and Federal codes, and other applicable laws and regulations. Where code requirements are at variance with Contract Documents, meet code requirements as a minimum requirement and include costs necessary to meet these in Contract. Machinery and equipment are to comply with OSHA requirements, as currently revised and interpreted for equipment manufacturer requirements. Install equipment provided per manufacturer recommendations.

B. Whenever this Specification calls for material, workmanship, arrangement or construction of higher quality and/or capacity than that required by governing codes, higher quality and/or capacity take precedence.

C. Drawings are intended to be diagrammatic and reflect the Basis of Design manufacturer's equipment. They are not intended to show every item in its exact dimensions, or details of equipment or proposed systems layout. Verify actual dimensions of systems (i.e., piping) and equipment proposed to assure that systems and equipment will fit in available space. Contractor is responsible for design and construction costs incurred for equipment other than Basis of Design, including, but not limited to, architectural, structural, electrical, HVAC, fire sprinkler, and plumbing systems.

D. Manufacturer's Instructions: Follow manufacturer's written instructions. If in conflict with Contract Documents, obtain clarification. Notify Engineer/Architect, in writing, before starting work.

E. Items shown on Drawings are not necessarily included in Specifications or vice versa. Confirm requirements in all Contract Documents.

F. Provide products that are UL listed.

G. Piping and duct insulation products to contain less than 0.1 percent by weight PBDE in all insulating materials.

H. ASME Compliance: ASME listed water heaters and boilers with an input of 200,000 BTUH and higher, hot water storage tanks which exceed 120 gallons, and hot water expansion tanks which are connected to ASME rated equipment or required by code or local jurisdiction.

I. Provide safety controls required by National Boiler Code (ASME CSD 1) for boilers and water heaters with an input of 400,000 BTUH and higher.

1.6 WARRANTY

A. Provide written warranty covering the work for a period of one year from date of Substantial Completion in accordance with Division 00, Contracting and Procurement Requirements, Division 01, General Requirements, Section 23 00 00, HVAC Basic Requirements and individual Division 23, HVAC Sections.

B. Sections under this Division can require additional and/or extended warranties that apply beyond basic warranty under Division 01, General Requirements and the General Conditions. Confirm requirements in all Contract Documents.

1.7 COORDINATION DOCUMENTS

A. Prior to construction, coordinate installation and location of HVAC equipment, ductwork, grilles, diffusers, piping, equipment, fire sprinklers, plumbing, cable trays, lights, and electrical services with architectural and structural requirements, and other trades (including ceiling suspension, and tile systems), and provide maintenance access requirements. Coordinate with submitted architectural systems (i.e. roofing, ceiling, finishes) and structural systems as submitted, including footings and foundation. Identify zone of influence from footings and ensure systems are not routed within the zone of influence.

B. Advise Architect in event a conflict occurs in location or connection of equipment. Bear costs resulting from failure to properly coordinate installation or failure to advise Architect of conflict.

C. Verify in field exact size, location, invert, and clearances regarding existing material, equipment and apparatus, and advise Architect of discrepancies between that indicated on Drawings and that existing in field prior to installation related thereto.

D. Submit final Coordination Drawings with changes as Record Drawings at completion of project.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Articles, fixtures, and equipment of a kind to be standard product of one manufacturer, including but not limited to pumps, fans, valves, control devices, air handlers, vibration isolation devices, etc.

2.2 STANDARDS OF MATERIALS AND WORKMANSHIP

A. Base contract upon furnishing materials as specified. Materials, equipment, and fixtures used for construction are to be new, latest products as listed in manufacturer's printed catalog data and are to be UL or ETL approved or have adequate approval or be acceptable by State, County, and City authorities.

B. Names and manufacturer's names denote character and quality of equipment desired and are not to be construed as limiting competition.

C. Hazardous Materials:

1. Comply with local, State of Oregon, and Federal regulations relating to hazardous materials.
2. Comply with Division 00, Procurement and Contracting Requirements and Division 01, General Requirements for this project relating to hazardous materials.
3. Do not use any materials containing a hazardous substance. If hazardous materials are encountered, do not disturb; immediately notify Owner and Architect. Hazardous materials will be removed by Owner under separate contract.

2.3 ACCESS PANELS

A. See Division 01, General Requirements and Division 08, Openings for products and installation requirements.

B. Confirm Access Panel requirements in Division 01, General Requirements, Division 08, Openings and individual Division 23, HVAC Sections. In absence of specific requirements in Division 01, General Requirements, comply with the following:

1. Provide flush mounting access panels for service of systems and individual components requiring maintenance or inspection. Where access panels are located in fire-rated assemblies of building, rate access panels accordingly.

    a. Ceiling access panels to be minimum 24-inch by 24-inch required and approved size.

    b. Wall access panels to be minimum of 12-inch by 12-inch required and approved size.

    c. Provide screwdriver operated catch.

    d. Manufacturers and Models:

        1) Drywall: Karp KDW.

        2) Plaster: Karp DSC-214PL.

        3) Masonry: Karp DSC-214M.

        4) 2 hour rated: Karp KPF-350FR.

        5) Manufacturers: Milcor, Elmdor, Acudor or approved equivalent.

PART 3 - EXECUTION

3.1 ACCESSIBILITY AND INSTALLATION

A. Confirm Accessibility and Installation requirements in Division 00, Procurement and Contracting Requirements and Division 01, General Requirements, Section 23 00 00, HVAC Basic Requirements and individual Division 23, HVAC Sections.

B. Install equipment having components requiring access (i.e., drain pans, drains, control operators, valves, motors and vibration isolation devices) so that they may be serviced, reset, replaced or recalibrated by service people with normal service tools and equipment. Do not install equipment in obvious passageways, doorways, scuttles or crawlspaces which would impede or block intended usage.

C. Install equipment and products complete as directed by manufacturer's installation instructions including all appurtenances recommended in manufacturer's installation instructions, at no additional charge to Owner. Obtain installation instructions from manufacturer prior to rough-in of equipment and examine instructions thoroughly.

When requirements of installation instructions conflict with Contract Documents, request clarification from Architect and Engineer prior to proceeding with installation. This includes proper installation methods, sequencing and coordination with other trades and disciplines.

D. Earthwork:

1. Confirm Earthwork requirements in Contract Documents. In absence of specific requirements, comply with individual Division 23, HVAC Sections and the following:

   a. Perform excavation, dewatering, shoring, bedding, and backfill required for installation of work in this Division in accordance with related earthwork Sections. Contact utilities and locate existing utilities prior to excavation. Repair any work damaged during excavation or backfilling.

   b. Excavation: Do not excavate under footings, foundation bases, or retaining walls.

   c. Provide protection of underground systems. Review the project Geotechnical Report for references to corrosive or deleterious soils which will reduce the performance or service life of underground systems materials.

E. Firestopping:

1. Confirm Firestopping requirements in Division 07, Thermal and Moisture Protection. In absence of specific requirements, comply with individual Division 23, HVAC Sections and the following:

   a. Coordinate location and protection level of fire and/or smoke rated walls, ceilings, and floors. When these assemblies are penetrated, seal around piping, ductwork and equipment with approved firestopping material. Install firestopping material complete as directed by manufacturer's installation instructions. Meet requirements of ASTM E814, Standard Test Method for Fire Tests of Through-Penetration Fire Stops.

F. Pipe Installation:

1. Provide installation of piping systems coordinated to account for expansion and contraction of piping materials and building, as well as anticipated settlement or shrinkage of building. Install work to prevent damage to piping, equipment, and building and its contents. Provide piping offsets, loops, seismic flexible joints, expansion joints, sleeves, anchors or other means to control pipe movement and minimize forces on piping. Verify anticipated settlement and/or shrinkage of building with Project Structural Engineer. Verify construction phasing, type of

building construction products and rating for coordinating installation of piping systems.

2. Include provisions for servicing and removal of equipment without dismantling piping.

G. Plenums:

1. Plenums: Materials within plenums shall be noncombustible or shall have a flame spread index of not more than 25 and a smoke-developed index of not more than 50 when tested in accordance with ASTM E 84 or UL 723. Immediately notify Architect / Engineer of any discrepancy.

3.2 SEISMIC CONTROL

A. Confirm Seismic Control requirements in Division 01, General Requirements, Structural documents, Section 23 05 48, Vibration and Seismic Controls for HVAC Equipment, and individual Division 23 HVAC Sections.

B. General:

1. Earthquake resistant designs for HVAC (Division 23) equipment and distribution, i.e. motors, ductwork, piping, equipment, etc. to conform to regulations of jurisdiction having authority.

2. Restraints which are used to prevent disruption of function of piece of equipment because of application of horizontal force to be such that forces are carried to frame of structure in such a way that frame will not be deflected when apparatus is attached to a mounting base and equipment pad, or to structure in normal way, utilizing attachments provided. Secure equipment and distribution systems to withstand a force in direction equal to value defined by jurisdiction having authority.

3. Provide stamped Shop Drawings from licensed Structural Engineer of seismic bracing and seismic movement assemblies for piping equipment and water heaters. Submit Shop Drawings along with equipment submittals.

4. Provide stamped Shop Drawings from licensed Structural Engineer of seismic flexible joints for piping and crossing building expansion or seismic joints. Submit Shop Drawings along with seismic bracing details.

C. Piping and Ductwork:

1. Per "Seismic Restraints Manual Guidelines for Mechanical Systems" latest edition published by SMACNA or local requirements.

D. Provide means to prohibit excessive motion of mechanical equipment during earthquake.

3.3 REVIEW AND OBSERVATION

A. Confirm Review and Observation requirements in Division 00, Procurement and Contracting Requirements, Division 01, General Requirements, Section 23 00 00, HVAC Basic Requirements and individual Division 23, HVAC Sections.

B. Notify Architect and Engineer, in writing, at following stages of construction so that they may, at their option, visit site for review and construction observation:

1. Underground system installation prior to backfilling.

2. Prior to covering walls.

3. Prior to ceiling cover/installation.

4. After major equipment is installed.

5. When main systems, or portions of, are being tested and ready for inspection by AHJ.

C. Final Punch:

1. Prior to requesting a final punch visit from the Engineer, request from Engineer the Mechanical Precloseout Checklist, complete the checklist confirming completion of systems' installation, and return to Engineer. Request a final punch visit from the Engineer, upon Engineer's acceptance that the mechanical systems are ready for final punch.

2. Costs incurred by additional trips required due to incomplete systems will be the responsibility of the Contractor.

3.4 CUTTING AND PATCHING

A. Confirm Cutting and Patching requirements in Division 00, Procurement and Contracting Requirements and Division 01, General Requirements. In absence of specific requirements, comply with individual Division 23, HVAC Sections and the following:

1. Proposed floor cutting/core drilling/sleeve locations to be approved by Project Structural Engineer. Submit proposed locations to Architect/Project Structural Engineer. Where slabs are of post tension construction, perform x-ray scan of proposed penetration locations and submit scan results including proposed

penetration locations to Project Structural Engineer/Architect for approval. Where slabs are of waffle type construction, show column cap extent and cell locations relative to proposed penetration(s).

2. Cutting, patching and repairing for work specified in this Division including plastering, masonry work, concrete work, carpentry work, and painting included under this Section will be performed by skilled craftsmen of each respective trade in conformance with appropriate Division of Work.

3. Additional openings required in building construction to be made by drilling or cutting. Use of jack hammer is specifically prohibited. Patch openings in and through concrete and masonry with grout.

4. Restore new or existing work that is cut and/or damaged to original condition. Patch and repair specifically where existing items have been removed. This includes repairing and painting walls, ceilings, etc. where existing conduit and devices are removed as part of this project. Where alterations disturb lawns, paving, and walks, surfaces to be repaired, refinished and left in condition matching existing prior to commencement of work.

5. Additional work required by lack of proper coordination will be provided at no additional cost to the Owner.

3.5 EQUIPMENT SELECTION AND SERVICEABILITY

A. Replace or reposition equipment which is too large or located incorrectly to permit servicing, at no additional cost to Owner.

B. Maintain design intent where equipment other than as shown as Basis of Design in Contract Documents is provided. Where equipment requires ductwork or piping arrangement, controls/control diagrams, or sequencing different from that indicated in Contract Documents, provide at no additional cost to Owner.

3.6 DELIVERY, STORAGE AND HANDLING

A. Confirm requirements in Division 00, Procurement and Contracting Requirements and Division 01, General Requirements. In absence of specific requirements, comply with individual Division 23, HVAC Sections and the following:

1. Handle materials delivered to project site with care to avoid damage. Store materials on site inside building or protected from weather, dirt and construction dust. Insulation and lining that becomes wet from improper storage and handling to be replaced before installation. Products and/or materials that become damaged due to water, dirt, and/or dust as a result of improper storage to be replaced before installation.

2. Protect equipment and pipe to avoid damage. Close pipe openings with caps or plugs. Keep motors and bearings in watertight and dustproof covers during entire course of installation.

3. Protect bright finished shafts, bearing housings and similar items until in service.

3.7 DEMONSTRATION

A. Confirm Demonstration requirements in Division 00, Procurement and Contracting Requirements and Division 01, General Requirements, Section 23 00 00, HVAC Basic Requirements and individual Division 23, HVAC Sections.

B. Upon completion of work and adjustment of equipment and test systems, demonstrate to Owner's Authorized Representative, Architect and Engineer that equipment furnished and installed or connected under provisions of these Specifications functions in manner required. Provide field instruction to Owner's Maintenance Staff as specified in Division 01, General Requirements, Section 23 00 00, HVAC Basic Requirements and individual Division 23, HVAC Sections.

C. Manufacturer's Field Services: Furnish services of a qualified person at time approved by Owner, to instruct maintenance personnel, correct defects or deficiencies, and demonstrate to satisfaction of Owner that entire system is operating in satisfactory manner and complies with requirements of other trades that may be required to complete work. Complete instruction and demonstration prior to final job site observations.

3.8 CLEANING

A. Confirm Cleaning requirements in Division 00, Procurement and Contracting Requirements, Division 01, General Requirements, Section 23 00 00, HVAC Basic Requirements and individual Division 23, HVAC Sections.

B. Upon completion of installation, thoroughly clean exposed portions of equipment, removing temporary labels and traces of foreign substances. Throughout work, remove construction debris and surplus materials accumulated during work.

3.9 INSTALLATION

A. Confirm Installation requirements in Division 00, Procurement and Contracting Requirements, Division 01, General Requirements, Section 23 00 00, HVAC Basic Requirements and individual Division 23, HVAC Sections.

B. Install equipment and fixtures in accordance with manufacturer's installation instructions, plumb and level and firmly anchored to vibration isolators. Maintain manufacturer's recommended clearances.

C. Start up equipment, in accordance with manufacturer's start-up instructions, and in presence of manufacturer's representative. Test controls and demonstrate compliance with requirements. Replace damaged or malfunctioning controls and equipment.

1. Do not place equipment in sustained operation prior to initial balancing of HVAC systems.

D. Provide miscellaneous supports/metals required for installation of equipment, piping and ductwork.

3.10 PAINTING

A. Confirm Painting requirements in Division 01, General Requirements and Division 09, Finishes. In absence of specific requirements, comply with individual Division 23, HVAC Sections and the following:

1. Ferrous Metal: After completion of work, thoroughly clean and paint exposed supports constructed of ferrous metal surfaces in mechanical rooms, i.e., hangers, hanger rods, equipment stands, with one coat of black asphalt varnish for exterior or black enamel for interior, suitable for hot surfaces.

2. After acceptance by Authority Having Jurisdiction (AHJ), In a mechanical room, on roof or other exposed areas, machinery and equipment not painted with enamel to receive two coats of primer and one coat of rustproof enamel, colors as selected by Architect.

3. See individual equipment Specifications for other painting.

4. Structural Steel: Repair damage to structural steel finishes or finishes of other materials damaged by cutting, welding or patching to match original.

5. Piping and Ductwork: Clean, primer coat and paint exposed piping and ductwork on roof or at other exterior locations with two coats paint suitable for metallic surfaces and exterior exposures. Color selected by Architect.

6. Covers: Covers such as manholes, cleanouts and the like will be furnished with finishes which resist corrosion and rust.

3.11 ACCESS PANELS

A. Confirm Access Panel requirements in Division 01, General Requirements. In absence of specific requirements, comply with individual Division 23, HVAC Sections and the following:

1. Coordinate locations/sizes of access panels with Architect prior to work.

3.12 ACCEPTANCE

A. Confirm requirements in Division 00, Procurement and Contracting Requirements and Division 01, General Requirements. In absence of specific requirements, comply with individual Division 23, HVAC Sections and the following:

   1. System cannot be considered for acceptance until work is completed and demonstrated to Architect that installation is in strict compliance with Specifications, Drawings and manufacturer's installation instructions, particularly in reference to following:

      a. Testing and Balancing Reports

      b. Cleaning

      c. Operation and Maintenance Manuals

      d. Training of Operating Personnel

      e. Record Drawings

      f. Warranty and Guaranty Certificates

      g. Start-up/Test Document

      h. Commissioning Reports

3.13 FIELD QUALITY CONTROL

A. Confirm Field Quality Control requirements in Division 01, General Requirements, Section 23 00 00, HVAC Basic Requirements and individual Division 23, HVAC Sections.

B. Tests:

   1. Conduct tests of equipment and systems to demonstrate compliance with requirements specified. Reference individual Specification Sections for required tests. Document tests and include in Operation and Maintenance Manuals.

   2. During site evaluations by Architect or Engineer, provide appropriate personnel with tools to remove and replace trims, covers, and devices so that proper evaluation of installation can be performed.

3.14 LETTER OF CONFORMANCE

A. Provide Letter of Conformance, copies of manufacturers' warranties and extended warranties with a statement that HVAC items were installed in accordance with manufacturer's recommendations, UL listings and FM Global approvals. Include Letter of Conformance, copies of manufacturers' warranties and extended warranties in Operation and Maintenance Manuals.

3.15 ELECTRICAL INTERLOCKS

A. Where equipment motors are to be electrically interlocked with other equipment for simultaneous operation, utilize equipment wiring diagrams to coordinate with electrical systems so that proper wiring of equipment involved is affected.

3.16 TEMPORARY HEATING, COOLING AND HUMIDITY CONTROL

A. Provide temporary heating, cooling, controls, humidification and dehumidification as required to facilitate the construction of the project. Size and select temporary system based on the requirements of the various trades during construction. This includes, but is not limited to, drywall, case work, wood flooring and wood finishes that are subject to warping. Size and install system to prevent mold growth. Coordinate the location of the temporary system. The house system can be used. Develop a procedure for how the house system will be used including a sketch depicting the house system, how filtration will be used to prevent construction debris from entering the system and how often the filters will be changed, how the ductwork will be cleaned after use to ensure a clean system is turned over to the Owner and how the units are sized. Submit this procedure to the Mechanical Engineer for review. Follow National Air Duct Cleaners Association (NADCA) duct cleaning procedures and guidelines. Warranties for the house system, if new, to commence when the Owner moves in if house system is used as the means to maintain the climate within the building during construction. Include this warranty requirement in the original bid or proposal amount. Coordinate and provide any temporary power, controls, ductwork, piping, plumbing anchorage, miscellaneous steel and structural supports required to support the temporary system. Installation of the system to comply with all applicable codes and be acceptable to the Authority Having Jurisdiction (AHJ).

END OF SECTION

SECTION 23 05 29 - HANGERS AND SUPPORTS FOR HVAC PIPING, DUCTWORK AND EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Work Included:

1. Hangers and Supports for HVAC Piping, Ductwork and Equipment
2. Wall and Floor Sleeves
3. Building Attachments
4. Flashing
5. Miscellaneous Metal and Materials

1.2 RELATED SECTIONS

A. Contents of Division 23, HVAC and Division 01, General Requirements apply to this Section.

1.3 REFERENCES AND STANDARDS

A. References and Standards as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.

B. In addition, meet the following:

1. ASCE 7-10, Minimum Design Loads for Buildings and Other Structures.
2. Terminology: As defined in MSS SP-90 "Guidelines on Terminology for Pipe Hangers and Supports".
3. Install ductwork and piping per SMACNA's requirements.
4. Hanger spacing installation and attachment to meet all manufacturer's requirements and MSS SP-58.

1.4 SUBMITTALS

A. Submittals as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.

1.5 QUALITY ASSURANCE

A. Quality assurance as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.

B. In addition, meet the following:

1. Welding:

   a. Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications".

2. Welding for Hangers:

   a. Qualify procedures and personnel according to AWS D9.1, Sheet Metal Welding Code for duct joint and seam welding.

3. Engineering Responsibility:

   a. Design and preparation of Shop Drawings and calculations for each multiple pipe support, trapeze, duct support equipment hangers/supports, and seismic restraint by a qualified Structural Professional Engineer.

      1) Professional Engineer Qualifications: A professional engineer who is legally qualified to practice in jurisdiction where project is located and who is experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for installations of hangers and supports that are similar to those indicated for this Project in material, design, and extent.

4. Manufacturers regularly engaged in the manufacture of bolted metal framing support systems, whose products have been in satisfactory use in similar service for not less than 10 years.

5. Support systems to be supplied by a single manufacturer.

1.6 WARRANTY

A. Warranty of materials and workmanship as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.

1.7 PERFORMANCE REQUIREMENTS

A. Provide pipe, ductwork and equipment hangers and supports in accordance with the following:

1. When supports, anchorages, and seismic restraints for equipment, and supports, anchorages, and seismic restraints for conduit, piping, and ductwork are not shown on the Drawings, the contractor is responsible for their design.

2. Connections to structural framing not to introduce twisting, torsion, or lateral bending in the framing members. Provide supplementary steel as required.

B. Engineered Support Systems:

1. Support frames such as pipe racks or stanchions for piping, ductwork, and equipment which provide support from below.

2. Equipment, ductwork and piping support frame anchorage to supporting slab or structure.

C. Provide channel support systems, for piping to support multiple pipes capable of supporting combined weight of supported systems, system contents, and test water.

D. Provide heavy-duty steel trapezes for piping to support multiple pipes capable of supporting combined weight of supported systems, system contents, and test water.

E. Provide seismic restraint hangers and supports for piping, ductwork and equipment. See Section 23 05 48, Vibration and Seismic Controls for HVAC Equipment.

F. Obtain approval from AHJ for seismic restraint hanger and support system to be installed for piping and equipment. See Section 23 05 48, Vibration and Seismic Controls for HVAC Equipment.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Hangers and Supports for HVAC Piping, Ductwork and Equipment:

1. Anvil International

2. B-Line Systems, Incorporated

3. Erico Company, Incorporated

4. Nelson-Olsen Incorporated

5. Rilco Manufacturing Company, Incorporated

6. Snappitz Thermal Pipe Shield Manufacturing

7. Unistrut Corporation

B. Wall and Floor Sleeves:

1. Thunderline Corporation “Link Seal”.

2. Or approved equivalent.

C. Building Attachments:

1. Anchor-It

2. Gunnebo Fastening Corporation

3. Hilti Corporation

4. ITW Ramset/Red Head

5. Masterset Fastening Systems, Incorporated

2.2 HANGERS AND SUPPORTS FOR HVAC PIPING, DUCTWORK AND EQUIPMENT

A. Hanger Rods: Hanger rods continuously threaded or threaded ends only in concealed spaces and threaded ends only in exposed spaces; finish electro-galvanized or cadmium-plated in concealed spaces and prime painted in exposed spaces; sizes per MSS.

B. Hanger Rod Couplings: Anvil Figure 136, B-Line Figure B3220, or approved equivalent; malleable iron rod coupling with elongated center sight gap for visual inspection; to have same finish as hanger rods.

C. Channel Hanging System:

1. Framing members No. 12 gauge formed steel channels, 1-5/8-inch square, conforming to ASTM A570 GR33, one side of channel to have a continuous slot within turned lips; framing nut with grooves and spring 1/2-inch size, conforming to ASTM 675 GR60; screws conforming to ASTM A307; fittings conforming to ASTM A575; parts enamel painted or electro-galvanized.

2. Concrete Inserts: Malleable iron body, hot dipped galvanized finish. Lateral adjustment. MSS Type 18.

D. Continuous Concrete Insert: Steel construction, minimum 12 gauge. Electrogalvanized finish. Pipe clamps and insert nuts to match.

E. Pipe Hangers:

1. Pipe Rings for Hanger Rods:

    a. Pipe Sizes 2-inches and Smaller: Adjustable swivel ring hanger, UL listed. Erico 100 or 101, Anvil Figures 69 or 104, or approved equivalent.

    b. Pipe Sizes 2-1/2-inches and Larger: Clevis type hangers with adjustable nuts on rod, UL listed. Anvil figure 260, Erico 400, or approved equivalent.

    c. Pipe hangers to have same finish as hanger rods.

F. Pipe Saddles and Shields:

1. Factory fabricated saddles or shields under piping hangers and supports for insulated piping.

2. Size saddles and shields for exact fit to mate with pipe insulation. 1/2 round, 18 gauge, minimum 12-inches in length (4-inch pipe and larger to be three times longer than pipe diameter).

G. Thermal Hanger Shield Inserts:

1. 100-PSI (690-kPa) minimum compressive strength calcium silicate insulation, encased in sheet metal shield or polyisocyanurate rigid foam exceeding the load bearing weight of the pipe at the hanger point with a PVC vapor barrier.

2. Material for Cold Piping: Water-repellent-treated, ASTM C533, Type I calcium silicate with vapor barrier or polyisocyanurate rigid foam with a PVC vapor barrier.

3. Material for Hot Piping: Water-repellent-treated ASTM C533, Type 1 calcium silicate or polyisocyanurate rigid foam with a PVC vapor barrier.

4. For Trapeze or Clamped System: Insert and shield cover entire circumference of pipe.

5. For Clevis or Band Hanger: Insert and shield cover lower 180 degrees of pipe.

6. Insert Length: Extend 2-inches beyond sheet metal shield for piping operating below ambient air temperature.

7. Thermal Hanger Shield Insulation Operating Temperature: Meet or exceed fluid temperature in pipe.

H. Freestanding Roof Supports: Polyethylene high-density UV resistant quick "pipe" block with foam pad.

2.3 WALL AND FLOOR SLEEVES

A. Pre-Engineered Firestop Pipe Penetration Systems: UL listed assemblies for maintaining fire rating of piping penetrations through fire-rated assemblies. Comply with ASTM E814.

B. Fabricated Accessories:

1. Steel Pipe Sleeves: Fabricate from Schedule 40 black or galvanized steel pipe. Remove end burrs by grinding.

2. Sheet Metal Pipe Sleeves: Fabricate from G-90 galvanized sheets closed with lock-seam joints. Provide the following minimum gauges for the sizes indicated:

   a. Sleeve Size 4-inches in Diameter and Smaller: 18 gauge.

   b. Sleeve Sizes 5-6-inches: 16 gauge.

   c. Sleeve Sizes 7-inches and Larger: 14 gauge.

   d. Fire-Rated Safing Material.

      1) Rockwool Insulation: Complying with FS-HH-I-558, Form A, Class IV, 6 pounds per cubic foot density with melting point of 1985 degrees F and K value of 0.24 at 75 degrees F.

      2) Calcium Silicate Insulation: Noncombustible, complying with FS-HH-I-523, Type II, suitable for 100 degrees F to 1200 degrees F service with K value of 0.40 at 150 degrees F.

2.4 BUILDING ATTACHMENTS

A. Beam Clamps:

1. MSS Type 19 and 23, wide throat, with retaining clip.

2. Universal Side Beam Clamp: MSS Type 20.

2.5 FLASHING

A. Steel Flashing: 26 gauge galvanized steel.

B. Safes: 8 mil thick neoprene.

C. Caps: Steel, 22 gauge minimum, 16 gauge at fire-resistant structures.

2.6 MISCELLANEOUS METAL AND MATERIALS

A. General:

1. Provide miscellaneous metal items specified, including materials, fabrication, fastenings and accessories required for finished installation, where indicated on drawings or otherwise not shown on drawings that are necessary for completion of the project. Contractor is responsible for their design.

2. Fabricate miscellaneous units to size shapes and profiles indicated or, if not indicated, of required dimensions to receive adjacent other work to be retained by framing. Except as otherwise shown, fabricate from structural steel shapes and plates and steel bars, of welded construction using mitered joints for field connection. Cut, drill and tap units to receive hardware and similar items.

B. Structural Shapes: Where miscellaneous metal items are needed to be fabricated from structural steel shapes and plates, provide members constructed of steel conforming with requirements of ASTM A36 or approved equivalent.

C. Steel Pipe: Provide seamless steel pipe conforming to requirements of ASTM A53, Type S, Grade A, or Grade B. Weight and size required as specified.

D. Fasteners: Provide fasteners of types as required for assembly and installation of fabricated items; surface-applied fasteners are specified elsewhere.

E. Bolts: Low carbon steel externally and internally threaded fasteners conforming with requirements of ASTM A307; include necessary nuts and plain hardened washers. For structural steel elements supporting mechanical material or equipment from building structural members or connection thereto, use fasteners conforming to ASTM A325.

F. Miscellaneous Materials: Provide incidental accessory materials, tools, methods, and equipment required for fabrication.

G. Provide hot dipped galvanized components for items exposed to weather. Cold galvanize field-welded joints and components. Use materials compatible with system being supported (i.e. aluminum for aluminum ductwork, stainless steel for stainless steel ductwork).

H. Use straps, threshold rods and wire with sizes required by SMACNA to support ductwork.

I. Grout:

1. ASTM C1107, Grade B, factory mixed and packaged, nonshrink and nonmetallic, dry, hydraulic-cement grout.

2. Characteristics: Post hardening and volume adjusting; recommended for both interior and exterior applications.

3. Properties: Nonstaining, noncorrosive, and non gaseous.

4. Design Mix: 5000-PSI (34.5-MPa), 28-day compressive strength.

PART 3 - EXECUTION

3.1 GENERAL INSTALLATION REQUIREMENTS

A. Verify building materials to have hangers and attachments affixed in accordance with hangers to be used. Provide supporting calculations.

B. Examine Drawings and coordinate for verification of exact locations of fire and smoke rated walls, partitions, floors and other assemblies. Indicate, by shading and labeling on Record Drawings such locations and label as "1-Hour Wall", "2-Hour Fire/Smoke Barrier", and the like. Determine proper locations for piping penetrations. Set sleeves in place in new floors, walls or roofs prior to concrete pour or grouting.

C. Install hangers, supports, anchors and sleeves after required building structural work has been completed in areas where the work is to be installed. Coordinate proper placement of inserts, anchors and other building structural attachments.

D. Equipment Clearances: Do not route ductwork, equipment, or piping through electrical rooms, IT rooms, or other electrical or electronic equipment spaces and enclosures and the like. Within equipment rooms, provide minimum 3-feet lateral clearance from all sides of electric switchgear panels. Do not route ductwork, equipment, or piping above any electric power or lighting panel, switchgear, or similar electric device. Coordinate with Electrical and coordinate exact ductwork, equipment or pipe routing to provide proper clearance with such items.

3.2 HANGERS AND SUPPORTS FOR HVAC PIPING, DUCTWORK AND EQUIPMENT

A. Hang rectangular sheet-metal ducts with a cross sectional area of less than 7 SF with galvanized strips of No. 16 USS gauge steel 1-inch wide, and larger ducts with steel angles and adjustable hanger rods similar to piping hangers. Support at a maximum of 8-feet on center.

B. Support horizontal ducts within 24-inches of each elbow and within 48-inches of each branch intersection.

C. Design hangers and supports to allow for expansion and contraction.

D. Provide aluminum supports for aluminum ductwork.

E. Provide stainless steel supports for stainless steel ductwork.

F. Support vertical ducts at maximum intervals of 16-feet and at each floor.

G. Install upper attachments to structures with an allowable load not exceeding one-fourth of failure (proof-test) load.

H. Install flexible ductwork per the more stringent of SMACNA HVAC Duct Construction Standards or the following:

1. Support horizontal duct runs at not more than 4 feet intervals.

2. Support vertical risers at not more than 6 feet intervals.

3. Limit sag between support hangers to 1/2-inch per foot of spacing support.

4. Supports shall be rigid and shall be not less than 1.5-inches wide at point of contact with the duct surface.

5. Duct bends shall be not less than 1.5 duct diameter bend radius.

I. Use double nuts and lock washers on threaded rod supports.

J. Floor supports in mechanical rooms to be elevated 1-inch above finish floor and void space filled with masonry grout.

K. Anchor ducts securely to building in such a manner as to prevent transmission of vibration to structure. Do not connect duct hanger straps directly to roof deck. Do not support ducts from other ducts, piping or equipment.

L. Attach strap hangers installed flush with end of sheet-metal duct run to duct with sheet-metal screws.

M. Construct exterior ductwork or ductwork which is otherwise exposed to weather watertight and slope 1/4-inch per foot to avoid standing water.

N. Exposed ductwork hung in clean areas such as sanitary areas, pharmaceutical areas, wash down areas or food process areas to be installed using double end, food grade trapeze hanger rods suitable for use with food grade strut.

O. Channel Support System Installation:

1. Arrange for grouping of parallel runs of piping and support together on field-assembled channel systems.

2. Field assemble and install according to manufacturer's written instructions.

P. Install hangers and supports complete with necessary inserts, bolts, rods, nuts, washers, and other accessories.

Q. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.

R. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.

S. Adjust hangers so as to distribute loads equally on attachments. Provide grout under supports to bring piping, ductwork and equipment to proper level and elevations.

T. Prime paint ferrous nongalvanized hangers, accessories, and supplementary steel which are not factory painted.

U. Horizontal Piping Hangers and Supports; Horizontal and Vertical Piping, and Hanger Rod Attachments:

1. Factory fabricated horizontal piping hangers and supports complying with MSS SP-58, to suit piping systems and in accordance with manufacturer's published product information.
2. Use only one type by one manufacturer for each piping service.
3. Select size of hangers and supports to exactly fit pipe size for bare piping, and to exactly fit around piping insulation with saddle or shield for insulated piping.
4. Pipe support spacing (pipe supported in ceiling or floor-supported) to meet latest applicable Code and manufacturer's requirements.
5. Provide copper-plated hangers and supports for uninsulated copper piping systems.

V. Plumber's Tape not permitted as pipe hangers or pipe straps.

W. Comply with MSS SP-58. Install hangers, supports, clamps, and attachments as required to properly support piping from building structure. For horizontally hung grooved-end piping, provide a minimum of 2 hangers per pipe section.

X. Pipe Ring Diameters:

1. Uninsulated and Insulated Pipe, Except Where Oversized Pipe Rings are Specified: Ring inner diameter to suit pipe outer diameter.

2. Insulated Piping Where Oversized Pipe Rings are Specified and Vibration Isolating Sleeves: Ring inner diameter to suit outer diameter of insulation or sleeve.

Y. Oversize Pipe Rings: Provide oversize pipe rings of 2-inch and larger size.

Z. Pipe Support Brackets: Support pipe with pipe slides.

AA. Steel Backing in Walls: Provide steel backing in walls to support fixtures and piping hung from steel stud walls.

AB. Heavy-Duty Steel Trapeze Installation:

1. Arrange for grouping of parallel runs of horizontal piping and support together on field fabricated, heavy-duty trapezes.

2. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified above for individual pipe hangers.

3. Field fabricate from ASTM A 36/A 36M, steel shapes selected for loads being supported. Weld steel according to AWS D-1.1.

AC. Group parallel runs of horizontal piping to be supported together on trapeze-type hangers. Maximum spacings: MSS SP-58.

AD. Where piping of various sizes is to be supported together by trapeze hangers, space hangers for smallest pipe size or install intermediate supports for smaller diameter pipe.

AE. Do not support piping from other piping.

AF. Fire protection piping will be supported independently of other piping.

AG. Prevent electrolysis in support of copper tubing by use of hangers and supports which are copper plated.

AH. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and so maximum pipe deflections allowed by ASME B31.9, "Building Services Piping" is not exceeded.

AI. Insulated Piping:

1. Attach clamps and spacers to piping.

a. Piping Operating Above Ambient Air Temperature: Clamp may project through insulation.

b. Piping Operating Below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.

2. Do not exceed pipe stress limits according to ASME B31.9.

3. Install MSS SP-58, Type 39 protection saddles, if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.

4. Install MSS SP-58, Type 40 protective shields on cold piping with vapor barrier. Shields to span arc of 180 degrees.

5. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 (DN100) and larger if pipe is installed on rollers.

6. Shield Dimensions for Pipe, not less than the following:

   a. NPS 1/4 to NPS 3-1/2 (DN8 to DN 90): 12-inches long and 0.048-inch thick.

   b. NPS 4 (DN100): 12-inches long and 0.06-inch thick.

   c. NPS 5 and NPS 6 (DN125 and DN150): 18-inches long and 0.06-inch thick.

   d. NPS 8 to NPS 14 (DN200 to DN350): 24-inches long and 0.075-inch thick.

   e. NPS 16 to NPS 24 (DN400 to DN600): 24-inches long and 0.105-inch thick.

7. Pipes NPS 8 (DN200) and Larger: Include wood inserts.

   a. Insert Material: Length at least as long as protective shield.

8. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

AJ. Escutcheon Plates: Install around horizontal and vertical piping at visible penetrations through walls, partitions, floors, or ceilings, including penetrations through closets, through below ceiling corridor walls, and through equipment room walls and floors.

3.3 WALL AND FLOOR SLEEVES

A. Fabricated Pipe Sleeves:

1. Provide either steel or sheet metal pipe sleeves accurately centered around pipe routes. Size such that piping and insulation, if any, will have free movement within the sleeve, including allowance for thermal expansion. Sleeve diameter to

be determined by local seismic clearance requirements, and by waterproofing requirements.

2. Length: Equal to thickness of construction penetrated, except extend floor sleeves 1-inch above floor finish.

3. Provide temporary support of sleeves during placement in concrete and other work around sleeves. Provide temporary end closures to prevent concrete and other materials from entering pipe sleeves.

4. Seal each end airtight with a resilient nonhardening sealer, UL listed, fire rated ASTM 814.

B. Installation of metallic or plastic piping penetrations through non fire-rated walls and partitions and through smoke-rated walls and partitions:

1. Install fabricated pipe sleeve.

2. After installation of sleeve and piping, tightly pack entire annular void between piping or piping insulation and sleeve identification with specified material.

3. Seal each end airtight with a resilient nonhardening UL listed fire resistant ASTM 814.

C. Piping Penetrations Through Fire-Rated (One to Three Hour) Assemblies:

1. Select and install pre-engineered pipe penetration system in accordance with the UL listing and manufacturer's recommendation.

2. Provide proper sizing when providing sleeves or core-drilled holes to accommodate the penetration. Firestop voids between sleeve or core-drilled hole and pipe passing through to meet the requirements of ASTM E814.

3.4 BUILDING ATTACHMENTS

A. Factory fabricated attachments complying with MSS SP-58, selected to suit building substructure conditions and in accordance manufacturer's published product information.

B. Select size of building attachments to suit hanger rods.

C. Space attachments within maximum piping span length indicated in MSS SP-58.

D. Install building attachments within concrete slabs or attach to structural steel or wood. Install additional building attachments where support is required for additional concentrated loads, including valves, flanges, guides, strainers, expansion joints, and at changes in direction of piping.

E. Attachment to Wood Structure: Anvil side beam bracket Figure 202 for attachment to wooden beam or approved attachment for a wood structure.

F. Install mechanical-anchor fasteners in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.

G. Install concrete inserts before concrete is placed; fasten inserts to forms. Where concrete with compressive strength less than 2500 PSI is indicated, install reinforcing bars through openings at top in inserts.

H. Bolting: Provide bored, drilled or reamed holes for bolting to miscellaneous structural metals, frames or for mounts or supports. Flame cut, punched or hand sawn holes will not be accepted.

3.5 FLASHING

A. Flash and counterflash where piping, ductwork and equipment passes through weather or waterproofed walls, floors, and roofs.

B. Provide 12-inch minimum height curbs for roof-mounted mechanical equipment. Flash and counter flash with galvanized steel, soldered and waterproofed.

3.6 MISCELLANEOUS METAL AND MATERIALS

A. General: Verify dimensions prior to fabrication. Form metal items to accurate sizes and configurations as indicated on drawings and otherwise required for proper installation; make with lines straight and angles sharp, clean and true; drill, countersink, tap, and otherwise prepare items for connections with work of other trades, as required. Fabricate to detail of structural shapes, plates and bars; weld joints where practicable; provide bolts and other connection devices required. Include anchorages; clip angles, sleeves, anchor plates, and similar devices. Hot dipped galvanize after fabrication items installed in exterior locations. Set accurately in position as required and anchor securely to building construction. Construct items with joints formed for strength and rigidity, accurately machining for proper fit; where exposed to weather, form to exclude water.

B. Finishes:

1. Ferrous Metal: After fabrication, but before erection, clean surfaces by mechanical or chemical methods to remove rust, scale, oil, corrosion, or other substances detrimental to bonding of subsequently applied protective coatings. For metal items exposed to weather or moisture, galvanize in manner to obtain

G90 zinc coating in accordance with ASTM A123. Provide other non-galvanized ferrous metal with 1 coat of approved rust-resisting paint primer, in manner to obtain not less than 1.0 mil dry film thickness. Touch-up damaged areas in primer with same material, before installation. Apply zinc coatings and paint primers uniformly and smoothly; leave ready for finish painting as specified elsewhere.

2. Metal in Contact with Concrete, Masonry and Other Dissimilar Materials: Where metal items are to be erected in contact with dissimilar materials, provide contact surfaces with coating of an approved zinc-chromate primer in manner to obtain not less than 1.0 mil dry film thickness, in addition to other coatings specified in these specifications.

3. For Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and apply galvanizing repair paint to comply with ASTM A780.

C. Coordinate and furnish anchorages, setting drawings, diagrams, templates, instructions, and directions for installation of anchorages, such as concrete inserts, sleeves, anchor bolts and miscellaneous items having integral anchors, which are to be embedded in concrete or masonry construction. Coordinate delivery of such items to project site.

D. Fastening to In-Place Construction: Provide anchorage devices and fasteners where necessary for securing miscellaneous metal fabrications to in-place construction; including, threaded fasteners for concrete and masonry inserts, toggle bolts, through-bolts, lag bolts, wood screws and other connectors as required. Avoid cutting concrete reinforcing when drilling for inserts. Reference structural drawings and reinforcing shop drawings and determine locations of stirrups prior to drilling into concrete.

E. Cutting, Fitting and Placement: Perform cutting, drilling and fitting required for installation of miscellaneous metal fabrications. Set work accurately in location, alignment and elevation, plumb, level, true and free of rack, measured from established lines and levels. Provide temporary bracing or anchors in formwork for items, which are to be built into concrete masonry or similar construction.

F. Field Welding: Comply with AWS Code for procedures of manual shielded metal-arc welding, appearance and quality of welds made, and methods used in correcting welding work.

G. Setting Loose Plates: Clean concrete and masonry bearing surfaces of any bond reducing materials, and roughen to improve bond to surfaces. Clean bottom surface of bearing plates.

H. Set loose leveling and bearing plates on wedges, or other adjustable devices. After the bearing members have been positioned and plumbed, tighten the anchor bolts.

Do not remove wedges or shims, but if protruding, cut-off flush with edge of the bearing plate before packing with grout. Use metallic non-shrink grout in concealed locations where not exposed to moisture; use non-metallic non-shrink grout in exposed locations, unless otherwise indicated.

I. Pack grout solidly between bearing surfaces and plates to ensure that no voids remain.

J. Cut, drill, and fit miscellaneous metal fabrications for heavy-duty steel trapezes and equipment supports.

K. Fit exposed connections together to form hairline joints. Field-weld connections that cannot be shop-welded because of shipping size limitations.

L. Field Welding: Comply with AWS D1.1 procedures for shielded metal arc welding, appearance and quality of welds, and methods used in correcting welding work, and with the following:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.

2. Obtain fusion without undercut or overlap.

3. Remove welding flux immediately.

4. Finish welds at exposed connections so no roughness shows after finishing and contours of welded surfaces match adjacent contours.

M. Provide galvanized components for items exposed to weather.

3.7 FIRE RATED SUPPORTS

A. Provide fire rated support as required by Codes.

END OF SECTION

SECTION 23 05 48 - VIBRATION AND SEISMIC CONTROLS FOR HVAC EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Work Included:

1. Vibration Isolation
2. Seismic Restraint Devices
3. Factory Finishes
4. Seismic-Bracing/Restraint Devices/Systems for Equipment, Piping and Ductwork

B. General:

1. Vibration isolation for mechanical ductwork, piping and equipment.
2. Seismic restraint for mechanical ductwork, piping and equipment.
3. Seismic Certification for equipment, hangers and systems
4. Special inspections for systems.

C. Scope of Work:

1. Vibration isolation and seismic restraint of new equipment and systems within project boundary defined in architectural drawings.
2. Provide supplementary structural steel for seismic restraint systems. No hanging from roof deck is permitted on this project, unless specifically allowed by Structural Engineer of Record in writing prior to bid.

1.2 RELATED SECTIONS

A. Contents of Division 23, HVAC and Division 01, General Requirements apply to this Section.

1.3 REFERENCES AND STANDARDS

A. References and Standards as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.

1.4 SUBMITTALS

A. Submittals as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.

B. In addition, provide:

1. Vibration Isolation:

    a. Product Data: Provide catalog data indicating size, type, load and deflection of each isolator; and percent of vibration transmitted based on lowest disturbing frequency of equipment.

    b. Shop Drawings: Showing complete details of construction for steel and concrete bases including:

        1) Fabrication, including anchorages and attachments to structure and to supported equipment. Include auxiliary motor slides and rails, base weights, equipment static loads, power transmission, component misalignment and cantilever loads.

        2) Equipment mounting holes.

        3) Dimensions.

        4) Size and location of concrete and steel bases and curbs.

        5) Isolation selected for each support point.

        6) Details of mounting brackets for isolator.

        7) Weight distribution for each isolator.

        8) Details of seismic snubbers.

        9) Code number assigned to each isolator.

    c. Design calculations: Provide calculations for selecting vibration isolators and for designing vibration isolation bases.

2. Seismic Restraint:

    a. Shop Drawings: Show compliance with requirements of Quality Assurance article of this Section. Shop drawings to be stamped by a professional Structural Engineer licensed in State of Oregon.

b. Calculations: Submit seismic calculations indicating restraint loadings resulting from design seismic forces. Include anchorage details and indicate quantity, diameter and depth of penetration of anchors. Calculations certified by professional Structural Engineer licensed in State of Oregon.

3. Seismic Restraint Details: Detail fabrication and attachment of seismic restraints and snubbers. Show anchorage details and indicate quantity, diameter and depth of penetration of anchors.

4. Submittals for Interlocking Snubbers: Include load deflection curves up to 1/2-inch deflection in x, y and z planes.

5. Welding certificates.

1.5 QUALITY ASSURANCE

A. Quality assurance as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.

B. In addition, meet the following:

1. Vibration Isolation:

a. Except for packaged equipment with integral isolators, single manufacturer selects and furnishes isolation required.

b. Deflections indicated on drawings are minimum actual static deflections for specific equipment supported.

c. Isolator Stability:

1) Size springs of sufficient diameter to maintain stability of equipment being supported. Spring diameters not less than 0.8 of compressed height at rated load.

2) Springs have minimum additional travel to solid equal to 50 percent of rated defection.

3) Springs support 200 percent of rated load, fully compressed, without deformation or failure.

d. Maximum Allowable Vibration Levels: Peak vibration velocities not exceed 0.08 in/sec. Correct equipment operating at vibration velocities that exceed this criteria.

2. Seismic Restraint:

a. Code and Standard Requirements:

   1) Seismic restraint of equipment, piping and ductwork to be in accordance with latest enacted version of OSSC Chapter 16.

b. Confirm Seismic Control requirements in Division 01, General Requirements and Structural documents.

c. Certification: See Seismic Design Table or schedules on Drawings for equipment, systems and seismic-restraint devices designated to have seismic certification/qualification. Horizontal and vertical load testing and analysis performed according to ASCE 7-10. Anchorage systems to bear anchorage preapproval number from an agency acceptable to authorities having jurisdiction, showing maximum seismic-restraint ratings. Ratings based on independent testing or calculations, if preapproved ratings are not available. Calculations (including combining shear and tensile loads) to support seismic-restraint designs must be sealed by qualified licensed professional engineer in State of Oregon. Testing and calculations must include both shear and tensile loads and one test or analysis at 45 degrees to weakest mode.

d. Seismic restraint and anchorage of permanent equipment and associated systems listed below to building structure be designed to resist total design seismic force prescribed in local building code:

   1) Floor- or roof-mounted equipment weighing 400 pounds or greater.

   2) Suspended, wall-mounted or vibration isolated equipment weighing 20 pounds or greater.

   3) In-line duct devices connected to ductwork weighing 75 pounds or greater.

   4) Housekeeping slabs: provide reinforcement and anchorage to building structure.

e. Where required, seismic sway bracing of suspended duct and piping meet following:

   1) Pipe and duct runs requiring seismic bracing have minimum of two traverse braces and one longitudinal brace. Longitudinal (or traverse) brace at 90 degree change in direction may act as traverse (or longitudinal) brace if located within 2-feet of change in direction.

2) Seismic bracing may not pass through seismic separation joint. Pipe or duct runs that pass through seismic separation joint must be restrained within 5-feet of both sides of separation.

3) Seismic brace assembly spacing not to exceed 40-feet transverse and 80-feet longitudinal.

f. Seismic restraints may be omitted from suspended piping and duct if following conditions are satisfied:

1) For piping or ducts supported by rod hangers 12-inches or less in length from top of duct to bottom of structural support. Top connections to structure have swivel joints, eye bolts, or vibration isolation hangers for entire length of system run.

2) Lateral motion of system will not cause damaging impact with surrounding systems or cause loss of system vertical support.

3) System must be welded steel pipe, brazed copper pipe, sheet metal duct or similar ductile material with ductile connections.

C. Seismic restraints, including anchors to building structure, be designed by registered professional Structural Engineer licensed in State of Oregon. Design includes:

1. Number, size, capacity and location of anchors for floor- or roof-mounted equipment. For curb-mounted equipment, provide design of attachment of both unit to curb and curb to structure.

2. Number, size, capacity and location of seismic restraint devices and anchors for vibration-isolation and suspended equipment. Provide calculations and test data verifying horizontal and vertical ratings of seismic restraint devices.

3. Number, size, capacity and location of braces and anchors for suspended piping and ductwork on as-built plan drawings.

4. Maximum seismic loads to be indicated on drawings at each brace location. Drawings bear stamp and signature of registered professional Structural Engineer who designed layout of braces.

1.6 WARRANTY

A. Warranty of materials and workmanship as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.

1.7 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

B. Seismic Snubber Units: Furnish replacement neoprene inserts for snubbers.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Vibration Isolation:

1. The VMC Group
2. B-Line Systems, Inc.
3. Kinetics Noise Control, Inc.
4. Mason Industries, Inc.
5. M.W. Saussé - Vibrex
6. Where Mason numbers are specified, equivalent products by listed manufacturers are acceptable.
7. Or approved equivalent.

B. Seismic Restraint Devices:

1. The VMC Group
2. B-Line Systems, Inc.
3. Kinetics Noise Control, Inc.
4. Mason Industries, Inc.
5. M.W. Saussé - Vibrex
6. California Dynamics Corporation
7. Cooper B-Line Tolco
8. Unistrut Diversified Products Co.; Wayne Manufacturing Division.

9. Hilti, Inc.

10. Or approved equivalent.

C. Factory Finishes:

1. Kynar 500 Fluoropolymer Coating

2. Or approved equivalent.

D. Seismic-Bracing/Restraint Devices/Systems for Equipment, Piping and Ductwork:

1. The VMC Group

2. Kinetics Noise Control, Inc.

3. Mason Industries, Inc.

4. Hilti, Inc.

5. Cooper B-Line, Inc.

6. California Dynamics Corporation

7. Unistrut

8. ISAT, Inc.

9. Where Mason numbers are specified, equivalent products by listed manufacturers are acceptable.

10. Or approved equivalent.

2.2 VIBRATION ISOLATION

A. Type 1 - Neoprene Pad: Natural rubber waffle pads, arranged in single or multiple layers, 3/4-inch thick per layer with pattern repeating on 1/2-inch centers; 50 durometer hardness; maximum loading 60 PSI. Minimum 1/4-inch thick steel load distribution plate and 1/16-inch shim plates between layers, factory cut to sizes matching requirements of supported equipment. Molded bridge with neoprene anchor bolt bushing and flat washer face to prevent metal to metal contact. Number of layers required for equipment scheduled. Mason Type: Super WMH.

B. Type 4a - Restrained Spring Isolators: Freestanding, steel, open-spring isolators with seismic restraint.

1. Housing: Steel with resilient vertical-limit stops (out of contact during normal operation) to prevent spring extension due to wind loads or if weight is removed; factory-drilled baseplate bonded to 1/4-inch thick, natural rubber or bridge bearing neoprene isolator pad attached to baseplate underside; and adjustable equipment mounting and leveling bolt that acts as blocking during installation. Restraining bolts have large rubber grommets to provide cushioning in vertical and horizontal directions. A minimum clearance of 3/8-inch maintained around restraining bolts so as not to interfere with spring action.

2. Outside Spring Diameter: Not less than 80 percent of compressed height of spring at rated load.

3. Minimum Additional Travel: 50 percent of required deflection at rated load.

4. Lateral Stiffness: More than 80 percent of rated vertical stiffness.

5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

6. Brackets: Manufacturer's standard bracket, utilize height saving brackets to accommodate height restrictions.

7. Mason Type: SLR.

C. Type 5c - Spring Hangers with Vertical-Limit Stop: Combination coil-spring and elastomeric-insert hanger with spring and insert in compression and with a vertical-limit stop.

1. Frame: Steel, fabricated for connection to threaded hanger rods and to allow for a maximum of 15 degrees of angular hanger-rod misalignment from vertical without binding or reducing isolation efficiency.

2. Outside Spring Diameter: Not less than 80 percent of compressed height of spring at rated load.

3. Minimum Additional Travel: 50 percent of required deflection at rated load.

4. Lateral Stiffness: More than 80 percent of rated vertical stiffness.

5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

6. Elastomeric Element: Molded, oil-resistant rubber or neoprene.

7. Adjustable Vertical Stop: Steel washer with neoprene washer "up-stop" on lower threaded rod.

8. Mason Type: RW30.

D. Type FC-1, Flexible duct connectors. See Specification Section 23 33 00 Air Duct Accessories.

E. Type FC-2A, Flexible Pipe Connector, Steel:

1. 321 stainless steel, close pitch, annular corrugated hose.

2. Exterior Sleeve: 304 stainless steel, braided.

3. Pressure Rating: 125 PSI at 70 degrees F for 12-inch and smaller pipe.

4. Joint: ANSI Class 150 carbon steel flanges.

5. Size: Use pipe sized units.

6. Minimum Allowable Offset: 3/4-inch on each side of installed center line.

7. Basis of Design: Metraflex Model MLP.

F. Type FC-2B, Flexible Pipe Connector, Copper:

1. Inner Hose: Bronze, close pitch, annular corrugated hose.

2. Exterior Sleeve: Braided bronze (for piping over 2-inches, to be 3 pound braided stainless steel).

3. Minimum Allowable Pressure Rating: 125 PSI at 70 degrees F.

4. Joint: Sweat ends.

5. Size: Use pipe sized units.

6. Minimum Allowable Offset: 3/8-inch on each side of installed center line.

7. Basis of Design: Metraflex Model BBS.

G. Type FC-2C, Flexible Pipe Connector, Gas:

1. Inner Hose: 304 stainless steel.

2. Exterior Sleeve: Braided, 304 stainless steel.

3. Minimum Allowable Pressure Rating: 150 PSI at 70 degrees F up to 4-inch pipe.

4. Joint: Threaded carbon steel.

5. Minimum Allowable Offset: 3/4-inch on each side of installed center line.

6. Basis of Design: Metraflex GASCT.

2.3 SEISMIC RESTRAINT DEVICES

A. Resilient Isolation Washers and Bushings: 1-piece, molded, bridge-bearing neoprene complying with AASHTO M 251 and having a durometer of 50, plus or minus 5, with a flat washer face.

B. Restraining Cables: Galvanized steel aircraft cables with end connections made of steel assemblies that swivel to final installation angle and utilize two clamping bolts for cable engagement. Mason Type: SCB.

C. Anchor Bolts: Seismic-rated, drill-in and stud-wedge or female-wedge type. Select anchor bolts with strength required for anchor and as tested according to ASTM E 488/E 488M.

2.4 FACTORY FINISHES

A. Provide manufacturer's standard prime-coat finish ready for field painting. Units mounted outdoors exposed to weather: Epoxy powder coated, with 1000 hour salt spray rating per ASTM B-117. For high levels of corrosion protection utilize:

1. Conform to AAMA 605.2.

2. Apply coating following cleaning and pretreatment.

3. Cleaning: AA-C12C42R1X.

4. Dry system before final finish application.

5. Total Dry Film Thickness: Approximately 1.2 mils, when baked at 450 degrees F for 10 minutes.

B. Finish:

1. Manufacturer's standard paint applied to factory-assembled and factory-tested equipment before shipping.

2. Powder coating on springs and housings.

3. Hardware be electrogalvanized. Hot-dip galvanize metal components for exterior use.

4. Baked enamel for metal components on isolators for interior use.

5. Color-code or otherwise mark vibration isolation and seismic-control devices to indicate capacity range.

2.5 SEISMIC-BRACING/RESTRAINT DEVICES/SYSTEMS FOR EQUIPMENT, PIPING AND DUCTWORK

A. General Requirements for Restraint Components: Rated strengths, features and applications to be as defined in reports by agency acceptable to authorities having jurisdiction.

B. Structural Safety Factor: Allowable strength in tension, shear and pullout force of components be at least four times maximum seismic forces to which they will be subjected.

C. Anchor bolts for attaching to concrete to be seismic-rated, drill-in and stud-wedge or female-wedge type.

D. Resilient Isolation Washers and Bushings: Oil- and water-resistant neoprene.

E. Maximum 1/4-inch air gap and minimum 1/4-inch thick resilient cushion.

PART 3 - EXECUTION

3.1 GENERAL INSTALLATION REQUIREMENTS

A. Set floor-mounted equipment with steel base rails on minimum 4-inch-high concrete housekeeping pads. Extend pad minimum 6-inches beyond footprint of equipment in each direction, but not less than twice the embedment depth of concrete anchors.

B. Provide mounts for equipment installed outdoors for wind loads of 30 lbs. psf applied to any exposed surface of isolated equipment.

C. Do not install equipment or pipe which makes rigid contact with building slabs, beams, studs, walls, etc.

D. Anchor baseplate to floor or structure. Provide rubber grommets and washers to isolate bolt from base plate. Under no circumstances is isolation efficiency to be destroyed when bolting isolators to floor.

E. Building Penetrations: Isolate water piping and ductwork penetrating wall, ceilings, floors or shafts from structure by piping isolator or by 3/8-inch thick foamed rubber insulation. Install units flush with finished structure face, using one for each side as required. Cut units to length if longer than structure thickness. Caulk around pipe or duct at equipment room wall.

F. Vibration isolators must not cause change of position of equipment or piping which would stress piping connections or misalignment shafts or bearings. Isolated equipment is to be level and in proper alignment with connecting ducts and pipes.

G. Pipe Hangers in Equipment Rooms: Support water and gas piping connected to rotating equipment within equipment rooms on spring and neoprene hangers. The first three hangers from a piece of vibrating equipment are to have a minimum of 1/2 static deflection of equipment isolators. Other isolators should have a minimum of 1/4 static deflection of equipment isolators.

H. Examination:

1. Examine areas and equipment to receive vibration isolation and seismic-control devices for compliance with requirements, installation tolerances and other conditions affecting performance.

2. Examine roughing-in of reinforcement and cast-in-place anchors to verify actual locations before installation.

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

I. Testing: Perform following field quality-control testing:

1. Isolator seismic-restraint clearance.

2. Isolator deflection.

3. Snubber minimum clearances.

J. Adjusting:

1. Adjust snubbers according to manufacturer's written recommendations.

2. Torque anchor bolts according to equipment manufacturer's written recommendations to resist seismic forces.

K. Cleaning: After completing equipment installation, inspect vibration isolation and seismic-control devices. Remove paint splatters and other spots, dirt and debris.

L. Demonstration: Engage factory-authorized service representative to train Owner's maintenance personnel to adjust, operate and maintain air-mounting systems. Reference Division 01, General Requirements.

3.2 VIBRATION ISOLATION

A. Reference 3.01, General Installation Requirements.

B. Install per manufacturer's instructions and recommendations.

C. Vibration isolators must be installed in strict accordance with manufacturer's written instructions and certified submittal data.

D. Install isolation as indicated on drawings by type and location and where indicated below.

E. Equipment Vibration Isolation Schedule:

Equipment	Size	Vibration Isolator Type	Minimum Deflection (in)
Fan-coils, Unit Heaters	All	Type 5C, FC-1,2	0.75
Condensing Units	0 to 4.5 tons	Type 1	0.2
Condensing Units	5+ tons	Type 4A	2.5
Utility Set Centrifugal Fans	All	4A	1.5
Axial, Cabinet, Centrifugal Inline Fans	0 to 23.5-inch diameter	Type 5C, FC-1	0.75
Axial, Cabinet, Centrifugal Inline Fans	24-inch+ diameter	Type 5C, FC-1	1.5
Propeller Fans	All	Type FC-1	0.25

F. Isolation Mounts:

1. Install minimum of four seismic snubbers on isolated equipment. Locate snubbers as close as possible to vibration isolators and bolt to equipment base and supporting structure.

2. Install resilient bolt isolation washers on equipment anchor bolts.

3. Provide flexible piping connection and flexible ductwork connection to equipment with isolation mounts or bases.

G. Isolating Hangers:

1. Support piping and ductwork connected to isolated equipment within equipment rooms on isolating hangers as scheduled on drawings. Unless otherwise noted, first three hangers from isolated equipment to have a minimum of 1/2 static deflection of equipment isolators. Other isolating hangers to have a minimum of 1/4 static deflection of equipment isolators.

2. Position isolating hanger elements as high as possible in hanger rod assembly, but not in contact with building structure. Install hangers so that hanger housing may rotate full 360 degrees about rod axis without contacting any object.

3. Unless otherwise noted, air supply units with internally isolated fans do not require isolating hangers for connecting pipes and ductwork.

4. Where parallel running pipes are hung together on an isolated trapeze, provide isolator deflections for largest determined by provisions for pipe isolation. Do not mix isolated and non-isolated pipes in same trapeze.

5. Install limit stops so they are out of contact during normal operation.

H. Adjusting:

1. Adjust isolators after piping systems have been filled and equipment is at operating weight.

2. Adjust limit stops on restrained spring isolators to mount equipment at normal operating height. After equipment installation is complete, adjust limit stops so they are out of contact during normal operation.

3. Attach thrust limits at centerline of thrust and adjust to a maximum of 1/4-inch movement during start and stop.

3.3 SEISMIC RESTRAINT DEVICES

A. Reference 3.01, General Installation Requirements.

B. Install in strict accordance with manufacturer's written instructions and certified submittal data.

C. Install and adjust seismic restraints so equipment, piping and ductwork supports are not degraded by restraints.

D. Restraints must not short circuit vibration isolation systems or transmit objectionable vibration or noise.

E. Install restraining cables at each trapeze, individual pipe hanger and hanging vibration isolated equipment. Provide restraining cables in each of the four directions of movement. Install restraining cables no less than 45 Degrees from vertical. At trapeze anchor locations, shackle piping to trapeze. Install cables so they do not bend across sharp edges of adjacent equipment or building structure.

F. Install steel angles or channel, sized to prevent buckling, clamped with ductile-iron clamps to hanger rods for trapeze and individual pipe hangers. At trapeze anchor locations, shackle piping to trapeze. Requirements apply equally to hanging equipment. Do not weld angles to rods.

3.4 FACTORY FINISHES

A. Reference 3.01, General Installation Requirements.

B. Install per manufacturer's instructions and recommendations.

C. Finishes to be factory-applied. No field patching or holidays allowed.

3.5 SEISMIC-BRACING/RESTRAINT DEVICES/SYSTEMS FOR EQUIPMENT, PIPING AND DUCTWORK

A. Reference 3.01, General Installation Requirements.

B. Install per manufacturer's instructions and recommendations.

C. Adjust seismic restraints to permit free movement of equipment within normal mode of operation.

END OF SECTION

SECTION 23 05 53 - IDENTIFICATION FOR HVAC PIPING, DUCTWORK AND EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Work Included:

1. Plastic Nameplates
2. Plastic Pipe Markers
3. Ceiling Tags
4. Plastic Duct Markers

1.2 RELATED SECTIONS

A. Contents of Division 23, HVAC and Division 01, General Requirements apply to this Section.

1.3 REFERENCES AND STANDARDS

A. References and Standards as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.

1.4 SUBMITTALS

A. Submittals as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.

1.5 QUALITY ASSURANCE

A. Quality assurance as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.

B. In addition, meet the following:

1. Manufacturer's Qualifications: Firms regularly engaged in manufacture of identification devices of types and sizes required.
2. Codes and Standards: Comply with ANSI A13.1 for lettering size, length of color field, colors, and viewing angles of identification devices unless otherwise indicated.

1.6 WARRANTY

A. Warranty of materials and workmanship as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. General: Manufacturer's standard products of categories and types required for each application as referenced in other Division 23, HVAC Sections. Where more than a single type is specified for application, provide single selection for each product category.

B. Plastic Nameplates:

1. Brady Corporation
2. Brimar
3. Champion America
4. Craftmark
5. Seton
6. Or approved equivalent.

C. Plastic Pipe Markers:

1. Brady Corporation
2. Brimar
3. Champion America
4. Craftmark
5. Seton
6. Or approved equivalent.

D. Ceiling Tags:

1. Brady Corporation
2. Brimar

3. Champion America

4. Craftmark

5. Seton

6. Or approved equivalent.

E. Plastic Duct Markers:

1. Brady Corporation

2. Brimar

3. Champion America

4. Craftmark

5. Seton

6. Or approved equivalent.

2.2 PLASTIC NAMEPLATES

A. Description: Engraving stock melamine plastic laminate in the size and thicknesses indicated, engraved with engraver's standard letter style of the sizes and wording indicated, black with white core (letter color), punched for mechanical fastening except where adhesive mounting is necessary because of substrate. Provide 1/8-inch thick material.

1. Letter Color: White.

2. Letter Height: 1/2-inch.

3. Background Color: Black.

4. Fasteners: Self-tapping stainless steel screws, except contact-type permanent adhesive where screws cannot or should not penetrate the substrate.

5. Access Panel Markers: Manufacturer's standard 1/16-inch thick engraved plastic laminate access panel markers, with abbreviations and numbers corresponding to concealed valve or devices/equipment. Include center hole to allow attachment.

2.3 PLASTIC PIPE MARKERS

A. Color: Conform to ASME A13.1 and ANSI Z535.1.

B. Plastic Pipe Markers (for external diameters of 6-inches and larger including insulation): Factory fabricated, flexible, semi- rigid plastic, preformed to fit around pipe or pipe covering; minimum information indicating flow direction arrow and identification of fluid being conveyed.

C. Plastic Tape Pipe Markers (for external diameters less than 6-inches including insulation): Flexible, vinyl film tape with pressure sensitive adhesive backing and printed markings. Minimum information indicating flow direction arrow and identification of fluid being conveyed.

D. Lettering:

1. 3/4-inch to 1-1/4-inch Outside Diameter of Insulation or Pipe: 8-inch long color field, 1/2-inch high letters.

2. 1-1/2-inch to 2-inch Outside Diameter of Insulation or Pipe: 8-inch long color field, 3/4-inch high letters.

3. 2-1/2-inch to 6-inch Outside Diameter of Insulation or Pipe: 12-inch long color field, 1-1/4-inch high letters.

2.4 CEILING TAGS

A. Description: Steel with 3/4-inch diameter color coded head.

B. Color code as follows:

1. Yellow - HVAC equipment.

2. Red - Fire dampers/smoke dampers.

3. Blue - Heating/cooling valves.

4. Ceiling tile labels, machine generated, adhesive backed tape labels with black letters, clear tape.

2.5 PLASTIC DUCT MARKERS

A. General: Manufacturer's standard laminated plastic, color-coded duct markers. Supply separate color codes for supply, exhaust, outside, return air and hazardous exhaust lab, chemical, fume hood, isolation room systems.

B. Include the Following Nomenclature:

1. Direction of air flow.

2. Duct service (supply, return, general exhaust, outdoor air), kitchen exhaust, dishwasher exhaust, fume hood exhaust, isolation room exhaust, etc.).

PART 3 - EXECUTION

3.1 GENERAL - INSTALLATION

A. Identify air handling units, pumps, heat transfer equipment, tanks, and water treatment devices with plastic nameplates riveted to equipment body.

B. Identify ductwork with plastic ductmarkers.

C. Identify piping, concealed or exposed, with plastic pipe markers.

D. Coordinate names, abbreviations and other designations used in mechanical identification work with corresponding designations shown, specified or scheduled. Provide numbers, lettering and wording as indicated or, if not otherwise indicated, as recommended by manufacturers or as required for proper identification and operation/maintenance of mechanical systems and equipment.

E. Multiple Systems: Where multiple systems of same generic name are shown and specified, provide identification which indicates individual system number as well as service (as examples: Chiller No. 3, Air Handling Unit No. 42, Standpipe F12, and the like).

F. Degrease and clean surfaces to receive adhesive for identification materials.

G. Coordination: Where identification is to be applied to surfaces which require insulation, painting or other covering or finish, including valve tags in finished mechanical spaces, install identification after completion of covering and painting. Install identification prior to installation of acoustical ceilings and similar removable concealment.

H. Install all products in accordance with manufacturer's instructions.

I. Manual Balancing Dampers: Provide 12-inch long orange marker ribbon to end of balancing damper handle.

3.2 PLASTIC NAMEPLATES

A. Install plastic nameplates with corrosive-resistant mechanical fasteners.

B. Identify control panels and major control components outside panels with plastic nameplates riveted to equipment body.

C. Identify thermostats with nameplates.

3.3 PLASTIC PIPE MARKERS

A. Install plastic pipe markers complete around pipe in accordance with manufacturer's instructions.

B. Identify service, flow direction, and pressure. Install in clear view and align with axis of piping. Locate identification not to exceed 20-feet (reduced to 10-feet in congested areas and mechanical equipment rooms) on straight runs including risers and drops, adjacent to each valve and Tee, at each side of penetration of structure or enclosure, and at each obstruction. Locate near branches, valves, control devices, equipment connections, access doors, floor/wall penetrations.

3.4 CEILING TAGS

A. Provide ceiling tags to locate valves, dampers, and equipment above accessible ceilings. Locate in corner of ceiling tee grid closest to equipment.

3.5 PLASTIC DUCT MARKERS

A. Identify air supply, return, exhaust, isolation room exhaust, and outside air intake ductwork with duct markers, showing ductwork service and direction of flow, in black or white (whichever provides most contrast with ductwork identification color). Identify with air handling unit identification number and area served. Locate identification at air handling unit, in mechanical rooms, at each side of penetration of structure or enclosure, at each obstruction, and within view of access doors/panels. In each space where ductwork is exposed, locate signs near points where ductwork originates or continues into concealed enclosures (shaft, underground or similar concealment) and at 50 foot spacing along exposed runs. Where noted on Drawings, identify ductwork in exposed/public locations.

B. Access Doors: Provide duct markers on each access door in ductwork and housings, indicating purpose of access (to what equipment) and other maintenance and operating instructions.

END OF SECTION

SECTION 23 05 93 - TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 - GENERAL

1.1 SUMMARY

A. Work Included:

1. General Requirements and Procedures
2. Fundamental Air Systems Balancing Procedures
3. Constant Volume Air Systems Balancing Procedures
4. Fume Hoods
5. Final Reports:
    a. Report Requirements
    b. General Report Data
    c. System Diagrams
    d. Air Handling Units
    e. Fans
    f. Duct Traverses
    g. Diffusers/Registers/Grilles
    h. Instrument Calibration
6. Additional Tests

1.2 RELATED SECTIONS

A. Contents of Division 23, HVAC and Division 01, General Requirements apply to this Section.

1.3 REFERENCES AND STANDARDS

A. References and Standards as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.

1.4 SUBMITTALS

A. Submittals as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.

B. In addition, provide:

1. Quality-Assurance Submittals: Submit two copies of evidence that the Testing, Adjusting, and Balancing (TAB) Agent and this Project's TAB team members meet the qualifications specified in the "Quality Assurance" Article below.

2. Pre-Construction Phase Report:

    a. Provide a pre-construction phase TAB Plan at least two weeks prior to the commencement of TAB work. This report is to include:

        1) A complete set of report forms intended for use on the project, with data filled in except for the field readings. Forms to be Project-specific.

        2) Marked up shop drawings identifying all HVAC equipment to be balanced, and associated outlets and terminal devices.

        3) Identification of the type, manufacturer, and model of the actual instruments to be used, and clear indication of which instrument will be used to take each type of reading. Calibration certifications are to be included.

        4) A narrative of any project specific and/or non-standard TAB procedures to be used, and the equipment or systems they apply to.

3. Contract Documents Examination Report: Within 45 days from the Contractor's Notice to Proceed, submit two copies of the Contract Documents review report as specified in Part 3 of this Section.

4. Strategies and Procedures Plan: Submit two copies of the TAB strategies and step-by-step procedures as specified in Part 3 below. Include a complete set of report forms intended for use on this Project.

5. Specify reports required because of editing procedures in Part 3 of this Section.

6. Certified TAB Reports: Submit two copies of reports prepared, as specified in this Section, on approved forms certified by the TAB Agent.

7. Sample Report Forms: Submit two sets of sample TAB report forms.

8. Test Instrument Calibration: Submit proof of calibration within the last 6 months.

9. Final Report.

10. Provide additional submittals to commissioning authority as dictated in commissioning specifications.

1.5 QUALITY ASSURANCE

A. Quality Assurance as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.

B. In addition, meet the following:

1. Balance Firm Qualifications:

a. General:

1) Procure services of independent TAB agency to balance, adjust and test water circulating and air moving equipment and air distribution or exhaust systems. Minimum experience: 5 years.

2) Provide proof of testing agency having successfully completed at least five projects of similar size and scope.

b. Testing and Balancing firm is certified by NEBB or AABC and has a NEBB Certified Professional (CP) or a AABC Test and Balancer Engineer (TBE) on staff.

c. Industry Standards: Testing and Balancing will conform to NEBB or AABC, and American National Standards Institute (ANSI) as follows:

1) NEBB: Comply with Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems.

2) AABC: Comply with National Standards for Total System Balance.

3) ANSI:

(a) S1.4 Specifications for sound level meters.

(b) S1.11 Specifications for Octave-Band and Fractional-Octave-Band analog and digital filters.

(c) ANSI S1.13 Methods for the Measurement of Sound Pressure Levels.

d. Test Observation: If requested, conduct tests in the presence of the Commissioning Authority, AHJ, Architect or the Architect's representative.

2. Code Compliance: Perform tests in the presence of the Authority Having Jurisdiction (AHJ) where required by the Authority Having Jurisdiction (AHJ).

3. Owner Witness: Perform tests in the presence of the Commissioning Authority, Architect, Architect's Representative, or Owner's representative.

4. Engineer Witness: The engineer or engineer's representative reserves the right to observe tests or selected tests to assure compliance with the specifications.

5. Simultaneous Testing: Test observations by the AHJ, the Owner's Authorized Representative and the engineer's representative need not occur simultaneously.

6. Do not perform TAB work until heating, ventilating, and air conditioning equipment has been completely installed and is operating continuously as required.

7. Conduct air testing and balancing with clean filters in place. Clean strainers prior to performing hydronic testing and balancing.

8. TAB Conference: Meet with the Commissioning Authority, Owner's and the Architect's representatives on approval of the TAB strategies and procedures plan to develop a mutual understanding of the details. Ensure the participation of TAB team members, equipment manufacturers' authorized service representatives, HVAC controls Installer, and other support personnel. Provide 7 days advance notice of scheduled meeting time and location.

    a. Agenda Items: Include at least the following:

        1) Submittal distribution requirements.

        2) Contract Documents examination report.

        3) TAB plan.

        4) Work schedule and Project site access requirements.

        5) Coordination and cooperation of trades and subcontractors.

        6) Coordination of documentation and communication flow.

9. Certification of TAB Reports: This certification includes the following:

    a. Review field data reports to validate accuracy of data and to prepare certified TAB reports.

b. Certify that the TAB team complied with the approved TAB plan and the procedures specified and referenced in this Specification.

10. TAB Reports: Use standard forms from AABC or NEBB.

11. Instrumentation Type, Quantity, and Accuracy: As described in AABC or NEBB.

12. Instrumentation Calibration: Calibrate instruments at least every 6 months or more frequently if required by the instrument manufacturer.

1.6 WARRANTY

A. Warranty of materials and workmanship as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.

B. In addition, provide:

1. TAB Agency provides warranty for a period of 90 days following submission of completed report, during which time, Owner may request a recheck of up to 10 percent of total number of terminals, or resetting of any outlet, coil, or device listed in the final TAB report.

2. Guarantee: Meet the requirements of the following programs:

a. Provide a guarantee on AABC or NEBB forms stating that the agency will assist in completing the requirements of the Contract Documents if the TAB Agent fails to comply with the Contract Documents. Guarantee includes the following provisions:

1) The certified Agent has tested, adjusted, and balanced systems according to the Contract Documents.

2) Systems are balanced to optimum performance capabilities within design and installation limits.

1.7 DEFINITIONS

A. Adjust: To regulate fluid flow rate and air patterns at the terminal equipment, such as to reduce fan speed or adjust a damper.

B. Balance: To proportion flows within the distribution system, including submains, branches, and terminals, according to design quantities.

C. Draft: A current of air, when referring to localized effect caused by one or more factors of high air velocity, low ambient temperature, or direction of airflow, whereby more heat is withdrawn from a persons skin than is normally dissipated.

D. Procedure: An approach to and execution of a sequence of work operations to yield repeatable results.

E. Report Forms: Test data sheets for recording test data in logical order.

F. System Effect: A phenomenon that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.

G. System Effect Factors: Allowances used to calculate a reduction of the performance ratings of a fan when installed under conditions different from those presented when the fan was performance tested.

H. TAB: Testing, Adjusting, and Balancing.

I. Terminal: A point where the controlled medium, such as fluid or energy, enters or leaves the distribution system.

J. Test: A procedure to determine quantitative performance of a system or equipment.

K. Testing, Adjusting, and Balancing (TAB) Agent: The entity responsible for performing and reporting the TAB procedures.

L. AABC: Associated Air Balance Council.

M. NEBB: National Environmental Balancing Bureau.

N. AMCA: Air Movement and Control Association.

O. SMACNA: Sheet Metal and Air Conditioning Contractors' National Association.

1.8 COORDINATION

A. Coordinate the efforts of factory-authorized service representatives for systems and equipment, HVAC controls installers, and other mechanics to operate HVAC systems and equipment to support and assist TAB activities.

B. Notice: Provide 7 days advance notice for each test. Include scheduled test dates and times.

C. Witness leakage and pressure tests carried out by Section 233100.

D. Perform TAB after leakage and pressure tests on air and water distribution systems have been satisfactorily completed.

PART 2 - PRODUCTS - NOT USED

PART 3 - EXECUTION

3.1 GENERAL REQUIREMENTS AND PROCEDURES

A. Project Conditions:

1. Full Owner Occupancy: The Owner will occupy the site and existing building during the entire TAB period. Cooperate with the Owner during TAB operations to minimize conflicts with the Owner's operations.

2. Partial Owner Occupancy: The Owner may occupy completed areas of the building before Substantial Completion. Cooperate with the Owner during TAB operations to minimize conflicts with the Owner's operations.

3. Non-Owner Occupancy: Complete balancing of building systems prior to Substantial Completion and owner occupancy.

B. General Requirements:

1. Where HVAC systems and/or components interface with life safety systems, including fire and smoke detection, alarm, and controls, coordinate scheduling and testing and inspection procedures with authorities having jurisdiction.

2. Perform TAB work with doors, closed windows, and ceilings installed etc., to obtain simulated or project operating conditions. Do not proceed until systems scheduled for TAB are clean and free from debris, dirt and discarded building materials.

3. Where Owner occupies building during the testing period, cooperate with Owner to minimize conflicts with Owner's operations.

C. Examination:

1. Examine Contract Documents to become familiar with project requirements and existing building record documents (if available) to discover conditions in systems' designs that may preclude proper TAB of systems and equipment.

   a. Contract Documents are defined in the General and Supplementary Conditions of the Contract.

   b. Verify that balancing devices, such as test ports, gauge cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers, are required by the Contract Documents. Verify that quantities and locations of these balancing devices are accessible and appropriate for effective balancing and for efficient system and equipment operation.

2. Examine approved submittal data of HVAC systems and equipment.

3. Examine project record documents described in Division 01, General Requirements.

4. Examine Architect's and Engineer's design data, including Basis of Design, HVAC system descriptions, statements of design assumptions for environmental conditions and systems' output, and statements of philosophies and assumptions about HVAC system and equipment controls.

5. Examine equipment performance data, including fan and pump curves. Relate performance data to project conditions and requirements, including system effects that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system. Calculate system effect factors to reduce the performance ratings of HVAC equipment when installed under conditions different from those presented when the equipment was performance tested at the factory. To calculate system effects for air systems, use tables and charts found in AMCA 201, "Fans and Systems," Sections 7 through 10; or in SMACNA's "HVAC Systems--Duct Design," Sections 5 and 6. Compare this data with the design data and installed conditions.

6. Coordinate requirements in system and equipment with this Section.

7. Examine system and equipment installations to verify that they are complete and that testing, cleaning, adjusting, and commissioning specified in individual Specification Sections have been performed.

8. Examine system and equipment test reports.

9. Examine HVAC system and equipment installations to verify that indicated balancing devices, such as test ports, gauge cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers, are properly installed, and their locations are accessible and appropriate for effective balancing and for efficient system and equipment operation.

10. Examine systems for functional deficiencies that cannot be corrected by adjusting and balancing.

11. Examine equipment for installation and for properly operating safety interlocks and controls.

12. Report deficiencies discovered before and during performance of TAB procedures.

D. Preparation:

1. Prepare a TAB plan that includes strategies and step-by-step procedures.

2. Complete system readiness checks and prepare system readiness reports. Verify the following:

   a. Permanent electrical power wiring is complete.

   b. Hydronic systems are filled, clean, and free of air.

   c. Automatic temperature-control systems are operational.

   d. Equipment and duct access doors are securely closed.

   e. Balance, smoke, and fire dampers are open.

   f. Isolating and balancing valves are open and control valves are operational.

   g. Ceilings are installed in critical areas where air-pattern adjustments are required and access to balancing devices is provided.

   h. Windows, doors and other portions of the building envelope can be closed so design conditions for system operations can be met.

3. Hold a pre-balancing meeting at least one week prior to starting TAB work.

   a. Attendance is required by installers whose work will be tested, adjusted, or balanced.

4. Provide instruments required for TAB operations. Make instruments available to Architect to facilitate spot checks during testing.

E. General TAB Procedures:

1. Perform TAB procedures on each system according to the procedures contained in AABC or NEBB and this Section.

2. Coordinate location of test probes prior to start of TAB procedures and make test probes available for Owner's tests after start of occupancy. Where required, cut insulation, ducts, pipes, and equipment cabinets for installation of test probes to the minimum extent necessary to allow adequate performance of procedures. After testing and balancing, close probe holes and patch insulation with new materials identical to those removed. Restore vapor barrier and finish according to the insulation Specifications for this Project.

3. Mark equipment settings with paint or other suitable, permanent identification material, including damper-control positions, valve indicators, fan-speed-control levers, and similar controls and devices, to show final settings.

F. Adjustment Tolerances:

1. Air Handling Systems: Adjust to within plus or minus 5 percent of design for supply systems and plus or minus 5 percent of design for return and exhaust systems.

2. Air Outlets and Inlets: Adjust total to within plus 10 percent and minus 5 percent of design. Adjust outlets and inlets in space to within plus or minus 10 percent of design.

3. Hydronic Systems: Adjust to within plus or minus 10 percent of design at coils and plus or minus 5 percent at system pumps and equipment.

4. Adjust supply, return, and exhaust air quantities to maintain pressurization in spaces indicated on Drawings. Note and document room-to-room pressurization and maintain these relationships. Adjust pressure controlled spaces to within plus or minus 0.01 in WC.

G. Recording and Adjusting:

1. Field Logs: Maintain written logs including:

   a. Running log of events and issues.

   b. Discrepancies, deficient or uncompleted work by others.

   c. Contract interpretation requests.

   d. Lists of completed tests.

2. Ensure recorded data represents actual measured or observed conditions.

3. Permanently mark settings of valves, dampers, and other adjustment devices allowing settings to be restored. Set and lock memory stops.

4. Mark on drawings locations where traverse and other critical measurements were taken and cross reference location in final report.

5. After adjustment, take measurements to verify balance has not been disrupted or that such disruption has been rectified.

6. Leave systems in proper working order, replacing belt guards, closing access doors, closing doors to electrical switch boxes, and restoring thermostats to specified settings.

7. At final inspection, recheck random selections of data recorded in report. Recheck points or areas as selected and witnessed by Owner's Authorized Representative, or Commissioning Agent.

3.2 FUNDAMENTAL AIR SYSTEMS BALANCING PROCEDURES

A. Examine air-handling equipment to ensure clean filters have been installed, bearings are greased, belts are aligned and tight, and equipment with functioning controls is ready for operation.

B. Examine terminal units, such as variable-air-volume boxes and mixing boxes, to verify that they are accessible and their controls are connected and functioning.

C. Examine heat-transfer coils for correct piping connections and for clean and straight fins.

D. Prepare test reports for both fans and inlets and outlets. Obtain manufacturer's outlet factors and recommended testing procedures. Cross check the summation of required outlet volumes with required fan volumes.

E. Prepare schematic diagrams of systems' "as-built" duct layouts.

F. Determine the best locations in main and branch ducts for accurate duct airflow measurements.

G. Check the airflow patterns from the outside-air louvers and dampers and the return- and exhaust-air dampers, through the supply-fan discharge and mixing dampers.

H. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.

I. Verify that motor starters are equipped with thermal protection, sized for the connected load.

J. Check dampers for proper position to achieve desired airflow path.

K. Check for airflow blockages.

L. Check that condensate drains are installed, trapped and primed and routed to drain.

M. Check for readily observable leaks in air-handling unit components and ductwork.

N. Use sheaves and pulleys to adjust the speed of belt drive fans to achieve design flow with motors running at 60 Hertz unless noted otherwise.

3.3 CONSTANT VOLUME AIR SYSTEMS BALANCING PROCEDURES

A. Adjust fans to deliver total design airflows within the maximum allowable rpm listed by the fan manufacturer. Adjust fans to deliver design airflow at the lowest possible speed.

1. Measure fan static pressures to determine actual static pressure as follows:

    a. Measure outlet static pressure as far downstream from the fan as practicable and upstream from restrictions in ducts such as elbows and transitions.

    b. Measure static pressure directly at the fan outlet or through the flexible connection.

    c. Measure inlet static pressure of single-inlet fans in the inlet duct as near the fan as possible, upstream from flexible connection and downstream from duct restrictions.

    d. Measure inlet static pressure of double-inlet fans through the wall of the plenum that houses the fan.

2. Measure static pressure across each air-handling unit component under final balanced condition.

3. Compare design data with installed conditions to determine variations in design static pressures versus actual static pressures. Recommend corrective action to align design and actual conditions.

4. Make required adjustments to pulley sizes, motor sizes, and electrical connections to accommodate fan-speed changes.

5. Do not make fan-speed adjustments that result in motor loading greater than full load amps. Do not increase fan speed beyond fan class rating. Modulate dampers and measure fan-motor amperage to ensure no overload will occur. Measure amperage in full cooling, full heating, and economizer modes to determine the maximum required brake horsepower.

6. Adjust volume dampers for main duct, submain ducts, and major branch ducts to design airflows within specified tolerances.

3.4 FUME HOODS

A. Determine total airflow into the room where the fume hood is located and balance systems to ensure adequate air supply to hoods.

1. Set fume-hood door opening at position of normal use.
2. Energize the exhaust fan and adjust airflow to provide the indicated average fume-hood face velocity at hood opening.
3. Measure exhaust airflow volume by measuring airflow by Pitot-tube duct traverse.
4. Record each face velocity measurement taken at 4- to 6-inch increments over the entire hood door opening.
5. Calculate the average face velocity by averaging velocity measurements.
6. Calculate the airflow volume of exhaust-hood face velocity by multiplying the calculated average face velocity by the opening area. Compare this quantity with exhaust volume at exhaust fan and report duct leakage.
7. Measure airflow volume supplied by makeup fan. Verify that the makeup system supplies the proper amount of air to keep the space at the indicated pressure with the exhaust systems in all operating conditions.
8. Retest for average face velocity. Adjust hood baffles, fan drives, and other parts of the system to provide the indicated average face velocity and the indicated auxiliary air-supply percentages.
9. Retest and adjust the systems until fume-hood performance complies with Contract Documents.
10. Adjust variable volume lab exhaust fans bypass camper(s) to maintain minimum stack velocities.

3.5 FINAL REPORTS

A. Report Requirements:

1. General:

   a. Computer generated in PDF format and tabulated, divided, and bookmarked into sections by tested and balanced systems.

b. Include a certification sheet in front of binder signed and sealed by the certified TAB engineer.

1) Include a list of the instruments used for procedures, along with proof of calibration.

c. Final Report Contents: In addition to the certified field report data, include the following:

1) Pump curves.

2) Fan Curves

3) Manufacturers Test Data

4) Field test reports prepared by system and equipment installers.

5) Other information relative to equipment performance, but do not include approved Shop Drawings and Product Data.

B. General Report Data:

1. In addition to the form titles and entries, include the following data in the final report, as applicable:

a. Title Page

b. Name and Address of TAB Agent

c. Project Name

d. Project Location

e. Architect's Name and Address

f. Engineer's Name and Address

g. Contractor's Name and Address

h. Report Date

i. Signature of TAB Agent who Certifies the Report

j. Summary of Contents, Including the Following:

1) Design versus Final Performance

2) Notable Characteristics of Systems

3) Description of System Operation Sequence if it varies from the Contract Documents

k. Nomenclature Sheets for Each Item of Equipment

l. Data for Terminal Units, including Manufacturer, Type Size, and Fittings

m. Notes to explain why certain final data in the body of reports vary from design values.

n. Test Conditions for Fans and Pump Performance Forms, Including the Following:

1) Settings for Outside-, Return-, and Exhaust-air Dampers

2) Conditions of Filters

3) Cooling Coil, Wet- and Dry-bulb Conditions

4) Face and Bypass Damper Settings at Coils

5) Fan Drive Settings, including Settings and Percentage of Maximum Pitch Diameter

6) Inlet Vane Settings for Variable-Air-Volume Systems

7) Settings for Supply-air, Static-pressure Controller

8) Other System Operating Conditions that affect Performance

C. System Diagrams:

1. Include schematic layouts of air and hydronic distribution systems. Present with single-line diagrams and include the following:

a. Quantities of Outside, Supply, Return, and Exhaust Airflows

b. Water and Steam Flow Rates

c. Duct, Outlet, and Inlet Sizes

d. Pipe and Valve Sizes and Locations

e. Terminal Units

f. Balancing Stations

D. Air Handling Units:

1. For air-handling units, split systems, fan coils, pumps, and evaporator units with coils, include the following:

a. Unit Data: Include the following:

1) Unit Identification

2) Location

3) Make and Type

4) Model Number and Unit Size

5) Manufacturer's Serial Number

6) Unit Arrangement and Class

7) Discharge Arrangement

8) Sheave Make, Size in inches, and Bore

9) Sheave Dimensions, Center-to-center and Amount of Adjustments in Inches

10) Number of Belts, Make, and Size

11) Number of Filters, Type, and Size

b. Motor Data: Include the following:

1) Make and Frame Type and Size

2) Horsepower and rpm

3) Volts, Phase, and Hertz

4) Full-load Amperage and Service Factor

5) Sheave Make, Size in Inches, and Bore

6) Sheave Dimensions, Center-to-center and Amount of Adjustments in Inches

c. Test Data: Include design and actual values for the following:

1) Total Airflow Rate in cfm (L/s)

2) Total System Static Pressure in Inches wg (Pa)

3) Fan rpm

4) Discharge Static Pressure in Inches wg (Pa)

5) Filter Static-pressure Differential in Inches wg (Pa)

6) Preheat Coil Static-pressure Differential in Inches wg (Pa)

7) Cooling Coil Static-pressure Differential in Inches wg (Pa)

8) Heating Coil Static-pressure Differential in Inches wg (Pa)

9) Outside Airflow in cfm (L/s)

10) Return Airflow in cfm (L/s)

11) Outside-air Damper Position

12) Return-air Damper Position

E. Fans:

1. Fan Test Reports: For supply, return, and exhaust fans, include the following:

a. Fan Data: Include the following:

1) System Identification

2) Location

3) Make and Type

4) Model Number and Size

5) Manufacturer's Serial Number

6) Arrangement and Class

7) Sheave Make, Size in Inches, and Bore

8) Sheave Dimensions, Center-to-center and Amount of Adjustments in Inches.

b. Motor Data: Include the following:

1) Make and Frame Type and Size

2) Horsepower and rpm

3) Volts, Phase, and Hertz

4) Full-load Amperage and Service Factor

5) Sheave Make, Size in Inches, and Bore

6) Sheave Dimensions, Center-to-center and Amount of Adjustments in Inches

7) Number of Belts, Make, and Size

c. Test Data: Include design and actual values for the following:

1) Total Airflow Rate in cfm

2) Total System Static Pressure in Inches wg

3) Fan rpm

4) Discharge Static Pressure in Inches wg

5) Suction Static Pressure in Inches wg

F. Duct Traverses:

1. Include a diagram with a grid representing the duct cross-section and record the following:

a. Report Data: Include the following:

1) System and Air-handling Unit Number

2) Location and Zone

3) Duct Static Pressure in Inches wg

4) Duct Size in Inches

5) Duct Area in SF

6) Design Airflow Rate in cfm

7) Design Velocity in fpm

8) Actual Airflow Rate in cfm

9) Actual Average Velocity in fpm

G. Diffusers/Registers/Grilles:

1. For diffusers, registers and grilles, include the following:

a. Unit Data: Include the following:

1) System and Air-handling Unit Identification

2) Location and Zone

3) Test Apparatus Used

4) Area Served

5) Air-terminal-device Make

6) Air-terminal-device Number from System Diagram

7) Air-terminal-device Type and Model Number

8) Air-terminal-device Size

9) Air-terminal-device Effective Area in SF

b. Test Data: Include design and actual values for the following:

1) Airflow Rate in cfm

2) Air Velocity in fpm

3) Final Airflow Rate in cfm

4) Final Velocity in fpm

5) Space Temperature in Degrees F

H. Instrument Calibration:

1. For instrument calibration, include the following:

a. Report Data: Include the following:

1) Instrument Type and Make

2) Serial Number

3) Application.

4) Dates of Use

b. Dates of Calibration.

3.6 ADDITIONAL TESTS

A. Within 90 days of completing TAB, perform additional testing and balancing to verify that balanced conditions are being maintained throughout and to correct unusual conditions.

B. Seasonal Periods: If initial TAB procedures were not performed during near-peak summer and winter conditions, perform additional inspections, testing, and adjusting during near-peak summer and winter conditions.

END OF SECTION

SECTION 23 07 00 - HVAC INSULATION

PART 1 - GENERAL

1.1 SUMMARY

A. Work Included:

1. Type A, Flexible Glass Wool Blanket
2. Type B, Duct Liner
3. Type 2, Flexible Elastomeric Pipe Insulation
4. Jacketing
5. Accessories
6. Duct Insulation Accessories
7. Duct Insulation Compounds

1.2 RELATED SECTIONS

A. Contents of Division 23, HVAC and Division 01, General Requirements apply to this Section.

1.3 REFERENCES AND STANDARDS

A. References and Standards as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.

B. In addition, meet the following:

1. Piping and duct insulation products to contain less than 0.1 percent by weight PBDE in all insulating materials.

1.4 SUBMITTALS

A. Submittals as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.

B. In addition, provide:

1. Installer qualifications.
2. Product Data: Identify thermal conductivity, thickness, and jackets (both factory and field applied, if any) for each type of product indicated.

3. Material Test Reports: From a qualified testing agency acceptable to authorities having jurisdiction indicating, interpreting, and certifying test results for compliance of insulation materials, sealers, attachments, cements, and jackets with requirements indicated. Include dates of tests.

4. Installer Certificates: Signed by the Contractor certifying that installers comply with requirements.

5. Submit manufacturer's installation instructions.

1.5 QUALITY ASSURANCE

A. Quality assurance as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.

B. In addition, meet the following:

1. Formaldehyde Free: Should be third-party certified with UL Environment Validation.

2. Recycled Content: A minimum of 40 percent post-consumer recycled glass content certified and UL validated.

3. Low Emitting Materials: For all thermal and acoustical applications of Glass Mineral Wool Insulation products, provide materials complying with the testing and products requirements of UL GREENGUARD Gold Certification.

4. Installer to have minimum 5 years' experience in the business of installing insulation.

1.6 WARRANTY

A. Warranty of materials and workmanship as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.

1.7 FIRE HAZARD CLASSIFICATION

A. Maximum fire hazard classification of the composite insulation construction as installed to be not more than a Flame Spread Index (FSI) of 25 and Smoke Developed Index (SDI) of 50 as tested by current edition of ASTM E84 (NFPA 255) method.

B. Test pipe insulation in accordance with the requirements of current edition of UL "Pipe and Equipment Coverings R5583 400 8.15".

C. Test duct insulation in accordance with current edition of ASTM E84, UL 723, NFPA 255, NFPA 90A and NFPA 90B.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Type A, Flexible Glass Wool Blanket:

1. Certainteed
2. Johns Manville
3. Knauf
4. Owens-Corning

B. Type B, Duct Liner:

1. Certainteed
2. Johns Manville
3. Knauf
4. Owens-Corning

C. Type 2, Flexible Elastomeric Pipe Insulation:

1. Insulation:
   a. Armacell LLC Armaflex
   b. K-Flex
   c. Or approved equivalent.
2. Glue:
   a. Armacell LLC Armaflex Low VOC Adhesive
   b. K-Flex
   c. Or approved equivalent.
3. Paint:
   a. Armacell LLC Armaflex
   b. K-Flex

c. Or approved equivalent.

D. Jacketing:

1. ITW Insulation Systems
2. General Insulation Company
3. Or approved equivalent.

E. Accessories:

1. ITW Insulation Systems
2. Or approved equivalent.

F. Duct Insulation Accessories:

1. Certainteed
2. Johns Manville
3. Owens-Corning

G. Duct Insulation Compounds:

1. Certainteed
2. Johns Manville
3. Owens-Corning

2.2 TYPE A, FLEXIBLE GLASS WOOL BLANKET

A. ASTM C553, Type 1, Class B-2; flexible blanket.

B. 'K' Value: 0.27 BTU*in/(hr*sf*F) at 75 degrees F installed, maximum service temperature: 250 degrees F.

C. Density: 0.75 pounds per cubic foot.

D. DBDE-free. UL/E validated to be formaldehyde-free.

E. Vapor Barrier Jacket: FSK aluminum foil reinforced with glass wool yarn and laminated to fire resistant Kraft, secured with UL listed pressure sensitive tape or outward clinched expanded staples and vapor barrier mastic as needed.

2.3 TYPE B, DUCT LINER

A. ASTM C1071; flexible blanket.

B. 'K' Value: ASTM C518, 0.25 BTU*in/(hr*sf*F) at 75 degrees F, maximum service temperature: 250 degrees F.

C. Noise Reduction Coefficient: 0.65 or higher based on ASTM C 423 "Type A mounting."

D. Maximum Velocity on Mat or Coated Air Side: 5,000 FPM.

E. Adhesive: UL listed waterproof type.

F. Fasteners: Duct liner galvanized steel pins, welded or mechanically fastened.

G. Erosion-Resistant Surfaces: UL 181.

H. ASTM G21 and ASTM G22 Microbial Growth Resistance.

I. UL GREENGUARD Certified does not support the growth of mold, fungi, or bacteria per ASTM C 1338 and meets UL Environment GREENGUARD Microbial Resistance Listing per UL 2824-"GREENGUARD Certification Program Method for Measuring Microbial Resistance". DBDE-free. UL/E validated to be formaldehyde-free.

2.4 TYPE 2, FLEXIBLE ELASTOMERIC PIPE INSULATION

A. Elastomeric Foam: ASTM C534; flexible, cellular elastomeric, molded or sheet.

1. Thermal Conductivity Value: As indicated in the insulation tables below.
2. Maximum Service Temperature of 220 degrees F.
3. Maximum Flame Spread: 25.
4. Maximum Smoke Developed: 50 (1-inch thick and below).
5. Connection: Waterproof vapor retarder adhesive as needed.
6. UV Protection: UV outdoor protective coating per manufacturer's requirements.

B. Glue: Contact adhesive specifically manufactured for cementing flexible elastomeric foam.

2.5 JACKETING

A. Canvas Jacket: UL listed fabric, 6 ounce/sq.yd., plain weave cotton treated with dilute fire retardant lagging adhesive.

B. Aluminum Jacket: 0.016-inch-thick sheet, (smooth/embossed) finish, with longitudinal slip joints and 2-inch laps, die-shaped fitting covers with factory attached protective liner.

C. Stainless Steel Jacket: Type 304 stainless steel, 0.010-inch, smooth finish.

D. Insulated Jacketing Tape: Venture Tape VentureClad Plus 1579CW Insulation Cladding, or approved equal.

2.6 ACCESSORIES

A. Equipment Insulation Jacketing: Presized glass cloth, not less than 7.8 ounces/sq.yd., except as otherwise indicated. Coat with gypsum based cement.

B. Equipment Insulation Compounds: Provide adhesives, cement, sealers, mastics and protective finishes as recommended by insulation manufacturer for applications indicated.

C. General: Provide staples, bands, wire, wire netting, tape corner angles, anchors, stud pins and metal covers as recommended by insulation manufacturer for applications indicated. Accessories, i.e., adhesives, mastics, cements and tape to have the same flame and smoke component ratings as the insulation materials with which they are used. Shipping cartons to bear a label indicating that flame and smoke ratings do not exceed those listed above. Provide permanent treatment of jackets or facings to impart flame and smoke safety. Provide nonwater soluble treatments. Provide UV protection recommended by manufacturer for outdoor installation.

2.7 DUCT INSULATION ACCESSORIES

A. Staples, bands, wires, tape, anchors, corner angles and similar accessories as recommended by insulation manufacturer for applications indicated.

2.8 DUCT INSULATION COMPOUNDS

A. Cements, adhesives, coatings, sealers, protective finishes and similar accessories as recommended by insulation manufacturer for applications indicated.

PART 3 - EXECUTION

3.1 GENERAL INSTALLATION REQUIREMENTS

A. Verification of Conditions:

1. Do not apply insulation until pressure testing and inspection of ducts and piping has been completed.

2. Examine areas and conditions under which duct and pipe insulation will be installed. Do not proceed with work until unsatisfactory conditions have been corrected.

B. Preparation: Clean and dry surfaces to be insulated.

C. Installation:

1. Insulation: Continuous through walls, floors and partitions except where noted otherwise.

2. Piping and Equipment:

a. Install insulation over clean, dry surfaces with adjoining sections firmly butted together and covering surfaces. Fill voids and holes. Seal raw edges. Install insulation in a manner such that insulation may be split, removed, and reinstalled with vapor barrier tape on strainer caps and unions. Do not install insulation until piping has been leak tested and has passed such tests. Do not insulate manholes, equipment manufacturer's nameplates, handholes, and ASME stamps. Provide beveled edge at such insulation interruptions. Repair voids or tears.

b. Cover insulation on pipes above ground, outside of building, with stainless steel jacketing. Position seam on bottom of pipe.

D. Provide accessories as required. See Part 2 Article "Accessories" above.

E. Protection and Replacement: Installed insulation during construction. Replace damaged insulation which cannot be repaired satisfactorily, including units with vapor barrier damage and moisture saturated units.

F. Labeling and Marking: Provide labels, arrows and color on piping and ductwork. Attach labels and flow direction arrows to the jacketing per Section 23 05 53, Identification for HVAC Piping, Ductwork and Equipment.

G. Ductwork:

1. Install insulation in conformance with manufacturer's recommendations to completely cover duct.

2. Butt insulation joints firmly together and install jackets and tapes smoothly and securely.

3. Apply duct insulation continuously through sleeves and prepared openings, except as otherwise specified. Apply vapor barrier materials to form complete unbroken vapor seal over insulation.

4. Coat staples and seals with vapor barrier coating.

5. Cover breaks in jacket materials with patches of same material as vapor barrier. Extend patches not less than 2-inches beyond break or penetration on all directions and secure with adhesive and staples. Seal staples and joints with vapor barrier coating.

6. Fill jacket penetrations. i.e., hangers, thermometers and damper operating rods, and other voids in insulation with vapor barrier coating. Seal penetration with vapor barrier coating. Insulate hangers and supports for cold duct in un-conditioned spaces to extent to prevent condensation on surfaces.

7. Seal and flash insulation terminations and pin punctures with reinforced vapor barrier coating.

8. Continue insulation at fire dampers and fire/smoke dampers up to and including those portions of damper frame visible at outside of the rated fire barrier. Insulating terminations at fire dampers in accordance with this Section.

9. Do not conceal duct access doors with insulation. Install insulation terminations at access door in accordance with this Section.

H. Insulated Pipe Exposed to Weather: Where piping is exposed to weather, cover insulation with aluminum jacket. Seal watertight jacket per manufacturer's recommendations. Install metal jacket with 2-inch overlap at longitudinal and butt joints with exposed lap pointing down. Secure jacket with stainless-steel draw bands 12-inches on center and at butt joints.

I. Insulation Shields: Provide hangers and shields (18 gauge minimum) outside of insulation for cold piping (<60 degrees F). Hot water piping hangers may penetrate insulation to contact pipe directly. Provide 18-inch long, noncompressible insulation section at insulation shields for lines 2-inches and larger (hot and cold) piping.

J. Ductwork Surfaces to be Insulated:

Item to be Insulated	System Insulation Type	Duct Size	Insulation Thickness
Supply ductwork where duct is not specified to be lined.	A	All	1.5-inch

Return ductwork where duct is not specified to be lined.	--	All	None
Outside Air Ducts	A	All	3-inch
HVAC plenums and unit housings not preinsulated	B	All	1.5-inch
Exhaust ducts within 10-feet of exterior of conditioned spaces	A	All	3-inch

1. Note: Insulation thickness shown is a minimum. If state codes require additional thickness, then provide insulation thickness per code requirements.

K. Piping Surfaces to be Insulated:

Item to be Insulated	System Insulation Type	Conductivity Range (Btu-inch per hour per SF per degrees F)	Pipe Size (Inches)	Insulation Thickness (Inches)
Refrigerant Suction Piping (40F to 60F)	2	0.21-0.27 at a mean rating temperature of 75 degrees F	<1 1 to <1.5 1.5 to <4 4 to <8 >= 8	0.5 0.5 1.0 1.0 1.0

1. Note: Insulation thickness shown is a minimum. If state code requires additional thickness, then provide insulation thickness per code requirements.

3.2 TYPE A, FLEXIBLE GLASS WOOL BLANKET

A. Install insulation in conformance with manufacturer's recommendations and requirements.

B. Duct Wrap: Cover air ducts per insulation table except ducts internally lined where internal duct lining is adequate to achieve adequate insulating values to meet local Energy Codes (indicate on shop drawings, locations where duct wrap is planned to be omitted and indicate internal duct lining insulating values to confirm they will meet the Energy Code.) Wrap tightly with circumferential joints butted and longitudinal joints overlapped minimum of 2-inches. On ducts over 24-inches wide, additionally secure insulation with suitable mechanical fasteners at 18-inches on center. Circumferential and longitudinal joints stapled with flare staples 6-inches on center and covered with 3-inch wide, foil reinforced tape.

3.3 TYPE B, DUCT LINER

A. Install insulation in conformance with manufacturer's recommendations and requirements.

B. Duct Liners: Mat finish surface on air stream side. Secure insulation to cleaned sheet metal duct with continuous (minimum 90) percent coat of adhesive. Secure liner with mechanical fasteners 15-inches on center or per manufacturer requirements. Accurately cut liner and thoroughly coat ends with adhesive. Butt joints tightly. Top and bottom Sections of insulation overlap sides. Factory/field coat exposed edges. Metal nosing for exposed leading or transverse edges and when velocity exceeds 3500 FPM or manufacturer rating on exposed edges. Keep duct liner clean and free from dust. At completion of project, vacuum duct liner if it is dirty or dusty. Do not use small pieces. If insulation is installed without horizontal, longitudinal, and end joints butted together, installation will be rejected and work removed and replaced with work that conforms to this Specification.

3.4 TYPE 2, FLEXIBLE ELASTOMERIC PIPE INSULATION

A. Flexible Elastomeric Insulation:

1. Slip insulation on pipe prior to connection. Butt joints sealed with manufacturer's adhesive. Insulate fitting with miter-cut pieces. Cover insulation exposed to weather and below grade with two coats of finish as recommended by manufacturer.

B. Flexible Elastomeric Tubing:

1. Flexible Elastomeric Tubing: Slip insulation over piping or, if piping is already installed, slit insulation and snap over piping. Joints and butt ends must be adhered with 520 adhesive.

C. See General Installation Requirements above.

D. Install insulation in conformance with manufacturer's recommendations and requirements.

E. Slip insulation on pipe prior to connection. Butt joints sealed with manufacturer's adhesive. Insulate fitting with miter-cut pieces. Cover insulation exposed to weather and undergrade with two coats of finish as recommended by manufacturer.

F. Install in accordance with manufacturer's instructions for below grade installation.

3.5 JACKETING

A. See General Installation Requirements above.

B. Install in accordance with manufacturer's instructions.

3.6 ACCESSORIES

A. Install insulation in conformance with manufacturer's instructions, recommendations and requirements.

B. See General Installation Requirements above.

C. Furnish and install accessories for all insulation types listed in this Section.

3.7 DUCT INSULATION ACCESSORIES

A. Install insulation in conformance with manufacturer's recommendations and requirements.

3.8 DUCT INSULATION COMPOUNDS

A. Install insulation in conformance with manufacturer's recommendations and requirements.

END OF SECTION

SECTION 23 09 00 - INSTRUMENTATION AND CONTROL PERFORMANCE SPECIFICATIONS

PART 1 - GENERAL

1.1 SUMMARY

A. Work Included:

1. Communications
2. Operator Interface
3. Controller Software
4. Web Based Access
5. BAS Graphics
6. Building Controllers
7. Application Specific Controllers
8. Advanced Application Controllers
9. Input/Output Interface
10. Power Supplies and Line Filtering
11. Control Panels
12. Auxiliary Control Devices
13. Wiring and Raceways
14. Smoke Detection for Buildings with a Fire Alarm System

B. This is a performance specification and Contractor is responsible for design tasks and engineering.

1.2 RELATED SECTIONS

A. Contents of Division 23, HVAC and Division 01, General Requirements apply to this Section.

1.3 REFERENCES AND STANDARDS

A. References and Standards as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.

B. In addition, meet the following:

1. Current edition of ANSI/ASHRAE Standard 135 and addendum, BACnet.
2. Current edition of UL 916 Underwriters Laboratories Standard for Energy Management Equipment, Canada and the US.
3. Current edition of FCC Part 15, Subpart J, Class A.
4. Current edition of BACnet Testing Laboratories (BTL).

1.4 SUBMITTALS

A. Submittals as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.

B. In addition, provide:

1. Prepare and submit a detailed schedule of work. Schedule to identify milestones such as equipment submittals, control panel diagrams, color graphic panel displays, Interlock.
2. Wiring diagrams, control program sequence software flow chart diagrams, conduit layout diagrams, device location diagrams, equipment and component deliveries, installation sequencing, controller startup, point to point startup, control programming, sequence testing, commissioning/acceptance testing and training.
3. Submit design drawings, sequences of operation, program listings, software flow charts and details for each typical piece of equipment and system being controlled. No work to be initiated or fabrication of any equipment started prior to the Owner's Authorized Representatives return of REVIEWED submittals.
   a. Sequence of Operation: The sequence of operation included in the design documents is intended only to communicate the Engineers’ general control intent and is not to be used as a direct reference for programming of the EMS system. Verbatim duplication of the Engineer’s Sequence of Operation on the submittals is discouraged and may result in non-approval of the submittal. Sequence of operation on submittals to accurately detail the system’s intended programming, and include details of enhancements, adjustments, or deviations from the Engineer’s sequence of operation. Submitted sequence of operation to be written with a logical and organized format and flow. Provide detailed, clear and unambiguous sequence of operation language. Point descriptors and point nomenclature referenced in the submitted sequence of operation to match those (to be) actually programmed. As-built submittal

Sequence of Operation to include modifications to the programming made as a result of any addendum, bulletins, RFI's, change orders, and commissioning.

4. Format: Make each submittal in one complete and contiguous package. Partial or unmarked submittals will be rejected without review.

5. Submit Manufacturers Data as Follows:

   a. Complete materials list of items proposed to be furnished and installed. A complete Bill of Materials, listing materials, components, devices, wire and equipment are required for this work. The Bill of Materials to be separate for each controller on its own page(s) and to contain the following information for each item listed:

      1) Manufacturer's Name and Model number with furnished options highlighted.

      2) Quantity of each by controller location.

      3) Description of product (generic).

      4) Specified item.

      5) Operating range or span.

      6) Operating point or setpoint.

   b. Manufacturer's specifications and other data required demonstrating compliance with the specified requirements, including but not limited to: Catalog cuts, technical data and descriptive literature on hardware, software, and system components to be furnished.

   c. The data to be clearly marked and noted to identify specific ranges, model numbers, sizes, and other pertinent data. Submit printed manufacturer's technical product data for each control device furnished, indicating dimensions, capacities, performance characteristics, electrical characteristics, finishes of materials and including printed installation instructions and start-up instructions.

   d. Unless specifically called for otherwise, provide bound copies of catalog cuts for standard products, not requiring specifically prepared Shop Drawings, for the following:

      1) Wire and Cable, Class II

      2) Face Plates for Devices

3) Disconnect Switches for Power Control

e. Where more than one item, size, rating or other variations appear on a catalog cut sheet, clearly identify items to be provided. These items to be properly indexed and referenced to identification numbers, designations and/or details on the Drawings.

6. Shop Drawings: Submit shop drawings for each controlled system, depicting the following information:

   a. Schematic flow diagram of system showing fans, pumps, coils, dampers, valves and other control/monitoring devices.

   b. Label each control device with initial setting or adjustable range of control. Label points in schematic diagrams with termination at corresponding controller.

   c. Electrical Wiring: Clearly differentiate between portions of wiring that are factory installed and portions of be field-installed.

   d. Details of control panel faces, including controls, instruments, and labeling.

   e. Interfaces to equipment furnished under other Specification Sections identifying numbers of wires, termination location, voltages and pertinent details. Responsibility for each end of the interfaces to be noted on these drawings whether or not they are a part of this Section.

   f. System architecture diagram showing the global connectivity of new controllers and any existing systems that will be connected to.

7. Equipment locations, wiring and piping schematics, details, panel configurations, sizes, damper motor mounting details, valve schedules, and a points list keyed to specific hardware submittals. Control wiring depicted as fully annotated ladder diagrams with terminations identified, completely configured as to the exact panel, wiring, relay, switch, and component configuration.

8. Tag Number Lists: Develop instruments tag number system and submit list for approval. Coordinate methods and number block with the Owner's Authorized Representative.

9. Format the Shop and Field Drawings to Include:

   a. A Title Sheet containing a drawing list, abbreviations list, symbols list, site and vicinity maps for project location and schedules.

b. Floor Plans showing proposed device locations and device nomenclatures.

c. A Riser Diagram illustrating conduit relationships between devices shown on the Floor Plans. Show device nomenclatures.

d. A Single-Line Diagram for each system showing signal relationships of devices within the system. Show device nomenclatures.

e. A Wiring Diagram for each assembly, enclosure or free standing device, showing:

    1) The Devices Within

    2) Wiring Connections

    3) Wire Identification

    4) Voltage Levels

    5) Fuse Ratings

f. Operations and Maintenance Manuals:

    1) Following approval of Shop Drawings of control equipment and prior to acceptance of control work, prepare Operating and Maintenance manuals describing operating, servicing, and maintenance requirements of control systems and equipment installed under this Section, in accordance the General and Special Conditions of these Specifications.

    2) Information contained in the manual for the above equipment to include the following:

        (a) Manufacturer's catalog cuts and printed descriptive bulletins.

        (b) Manufacturer's installation, operating, and maintenance instruction booklets. Complete instructions regarding the operation and maintenance of equipment involved.

        (c) Instrument calibration certificates.

        (d) Parts list and costs.

        (e) Complete nomenclature of replaceable parts, list of recommended spare parts for 12 months operation, their part numbers, current cost and name and address of the nearest vendor of replacement parts.

(f) Name, address and telephone number for closest source of spare parts.

(g) Wiring and schematic diagrams.

(h) Include final record copies of shop drawings.

(i) Copy of guarantees and warranties issued for the various items of equipment, showing dates of expiration.

(j) Reduced plans, diagrams, and control schematics.

(k) Copies of test results.

(l) Control System Operating Manual including: point of summary and point data base; complete printout of program listings; magnetic tape CD or DVD backup of Field Control Cabinet programs; cabinet layout; hard copy of graphic screens; hard copy of specified reports.

g. A final Bill of Quantities including a separate schedule for portable equipment, if delivered as part of this work.

h. Performance, Test and Adjustment Data: Comprehensive documentation of performance verification according to parameters specified in these specifications.

i. Record Drawings: Comply with Division 01, General Requirements and Section 23 00 00, HVAC Basic Requirements. Provide complete as-built submittals including "as-programmed" sequence of operation as well as final occupancy schedules.

1.5 QUALITY ASSURANCE

A. Quality assurance as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.

B. In addition, meet the following:

1. Installer Qualifications: Company specializing in performing work of the type specified in this Section with minimum five years' experience in the local area. Installers required to have successfully completed manufacturer's control system factory training.

1.6 WARRANTY

A. Warranty of materials and workmanship as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.

1.7 SYSTEM DESCRIPTION

A. Control system referenced throughout specifications and drawings as Building Automation System (BAS), Building Management System (BMS), or Energy Management System (EMS) interchangeably consists of high-speed, peer-to-peer network of DDC controllers, control system server, and operator workstation.

B. System software based on server/thin-client architecture, designed around open standards of web technology. Control system server accessed using a web browser over control system network, Owner's local area network, and remotely over Internet (through Owner's LAN). Intent of thin-client architecture is to provide operators complete access to control system via web browser. No special software other than web browser required to access graphics, point displays, and trends.

C. Local Area Network (LAN) either 10 or 100 Mpbs Ethernet network.

D. System will consist of open architecture that is capable of:

1. High speed Ethernet communication using TCP/IP protocol.

2. Native BACnet communications according to ANSI / ASHRAE Standard 135, latest edition. Provide necessary BACnet-compliant hardware and software to meet the system's functional specifications. Controller devices must be BTL tested and listed by an official BACnet Testing Laboratory and have the BTL mark issued.

E. Complete temperature control system to be DDC with electronic sensors and electronic/electric actuation valves and dampers.

F. Prepare individual hardware layouts, interconnection drawings, building riser/architecture diagram and sequence of control from the project design data. Any architecture diagrams on design drawings have been included as schematics only and are not meant to portray quantity of devices or power/data requirements.

G. Design, furnish, and install equipment cabinets, panels, data communication network infrastructure (including cables, conduits, outlets, connections, etc.) needed, and associated hardware.

H. Provide complete manufacturer's specifications for items that are supplied. Include vendor name and model number of every item supplied.

I. Provide a comprehensive operator and technician training program as described in these Specifications.

J. Provide as-built documentation, operator's terminal software, diagrams, and other associated project operational documentation (such as technical manuals) on approved media, the sum total of which accurately represents the final system.

K. Provide 120V power, low voltage power, transformers, etc. for control panels, transformer panels, and BAS devices. Install per Division 26, Electrical Specifications. Power for devices within this Specification Section is solely the responsibility of the BAS Contractor.

L. Conduit and raceway systems. Provide per Division 26, Electrical Specifications.

M. Devices, components, controllers, and software to be manufacturer's most current version at the time of installation.

1.8 SYSTEM PERFORMANCE

A. Performance Standards - System conforms to following minimum standards over network connections:

1. Graphic Display: Graphic with 20 dynamic points display with current data within 10 seconds.

2. Graphic Refresh: Graphic with 20 dynamic points update with current data within 8 seconds.

3. Object Command: Devices react to command of binary object within 2 seconds. Devices begin reacting to command of analog object within 2 seconds.

4. Object Scan: Data used or displayed at controller or workstation have been current within previous 6 seconds.

5. Alarm Response Time: Object that goes into alarm is annunciated at workstation within 45 seconds.

6. Program Execution Frequency: Custom and standard applications are capable of running as often as once every 5 seconds. Select execution times consistent with mechanical process under control.

7. Performance: Programmable controllers are able to completely execute DDC PID control loops at frequency adjustable down to once per second. Select execution times consistent with mechanical process under control.

8. Multiple Alarm Annunciation: Each workstation on network receive alarms within 5 seconds of other workstations.

B. Reporting Accuracy: System reports values with minimum end-to-end accuracy listed in Reporting Accuracy Table below.

1. Reporting Accuracy Table:

Measure Variable	Reported Accuracy
Space Temperature	Plus or Minus 1 degree F
Ducted Air	Plus or Minus 1 degrees F
Outside Air	Plus or Minus 2 degrees F
Delta-T	Plus or Minus 0.25 degree F

2. Note 1: Accuracy applies to 10 percent-100 percent of scale

3. Note 2: For both absolute and differential pressure

4. Note 3: Not including utility-supplied meters

C. Control Stability and Accuracy. Control loops maintain measured variable at setpoint within tolerances listed in Control Stability and Accuracy Table below.

1. Control Stability and Accuracy Table:

Controlled Variable	Control Accuracy	Range of Medium
Air Pressure	Plus or minus 0.2 inch wg	0-6 inch wg
	Plus or minus 0.01 inch wg	-0.1 to 0.1 inch wg
Space Temperature	Plus or minus 2.00 degrees F	
Duct Temperature	Plus or minus 3.0 degrees F	

PART 2 - PRODUCTS

2.1 OREGON/WASHINGTON MANUFACTURERS

A. Alerton

B. Automated Logic (ALC)

C. Delta Controls

D. Reliable Controls

E. Duct/Spot-Type Smoke Detectors (Buildings with Fire Alarm System):

1. See Division 28 for Products.

2.2 COMMUNICATIONS

A. Each controller to have communication port for connection to operator interface.

1. Internetwork operator interface and value passing to be transparent to internetwork architecture.

2. Operator interface connected to controller to allow operator to interface with each internetwork controller as if directly connected. Controller information such as data, status, reports, system software, and custom programs to be viewable and editable from each internetwork controller.

B. Inputs, outputs, and control variables used to integrate control strategies across multiple controllers to be readable by each controller on internetwork.

C. Operator Workstation to be capable of simultaneous direct connection and communication with BACnet/IP, OPC and TCP/IP networks without use of interposing devices such as PC or gateway with hard drive.

D. Workstations, Building Control Panels and Controllers with real-time clocks use time synchronization service. System automatically synchronizes system clocks daily from operator-designated device via internetwork. System automatically adjusts for daylight savings and standard time as applicable.

2.3 OPERATOR INTERFACE

A. Operator Interface: PC-based workstations reside on high-speed network with building controllers. Each workstation or each standard browser connected to server is able to access system information.

B. Hardware: Each operator workstation or web server consists of the following:

1. Computer: Hardware meets or exceeds DDC system manufacturer's recommended specifications and meet response times specified elsewhere in this document. Following hardware requirements also apply:

a. Hard disk have sufficient memory to store:

1) Required operator workstation software.

2) One year of trend data based on points specified to be trended at specified trend intervals.

b. Minimum hardware configuration includes:

1) Intel i7 Processor

2) 22-in LCD Monitor with at least 1024 x 768 Resolution

3) 8 GB of RAM

4) 48x CD-RW/DVD Optical Drive

5) 1 TB Hard Disk Drive Providing Data at 3 GB/sec

6) Ethernet 10/100 Network Interface Card

7) High Performance Graphics Card

8) Keyboard and Mouse

9) Color Inkjet Printer

10) UPS (uninterruptible power supply) installed at server, sized with sufficient capacity to allow full operation for 10 minutes or more.

C. System Software:

1. Operating System: Furnish concurrent multi-tasking operating system. Operating system also supports use of and includes other common software applications such as Microsoft Excel, Word, Microsoft Access and Adobe Acrobat. Acceptable operating systems are Windows 7 and Windows 10.

2. Dynamic Color Graphics:

a. Real-time color graphic displays dynamic and able to update displays.

b. Provide operator ability to change values (setpoints) and states in system controlled equipment directly from graphic display.

c. Custom Graphics. Provide custom graphics generation package.

d. Graphics Library. Furnish library of standard HVAC equipment graphics and include standard symbols for fans, pumps, coils, valves, piping, dampers, and ductwork.

3. Software to be manufacturer's most current version at the time of installation.

D. System Applications: Each workstation provides operator interface and off-line storage of system information. Provide following applications at each workstation:

1. Automatic System Database Save and Restore: Each workstation stores on hard disk copy of current database of each Building Controller. This database automatically updated whenever change is made in any system panel.

2. Manual Database Save and Restore: System operator able to manually save or clear database and initiate download of specified database from/to any panel.

3. System Configuration: Workstation software provides method of configuring system to allow for changes or additions by users and performs following tasks:

    a. Create, delete or modify control strategies.

    b. Add/delete objects to system.

    c. Tune control loops through adjustment of control loop parameters.

    d. Enable or disable control strategies.

    e. Generate hard copy records of control strategies on printer.

    f. Select points to be alarmed and define alarm state.

    g. Select points to be trended and initiate automatic recording of values.

    h. Start/Stop binary objects and adjust analog objects.

4. Security: Operator required to log on to system with user name and password in order to view, edit, add, or delete data. System security selectable for each operator.

5. System Diagnostics: System automatically monitor operation of workstations, printers, modems, network connections, building management panels, and controllers. Failure of any device to be annunciated.

6. Alarm Indication and Handling:

    a. Workstation provides visual means of alarm indication. Alarm indication becomes highest priority regardless of application(s) running.

b. System provides and archive log of alarm messages to hard drive. Alarm messages to include description of event-initiating object, source, location and time/date of alarm.

7. Trend Logs: Operator able to define custom trend log for any data object and include interval, start time, and stop time. Trend data sampled and stored on building controller panel, is archived on hard disk, and is retrievable for use in spreadsheets and standard database programs.

   a. System server to periodically gather historically recorded data stored in the building controllers and archive the information. Archived files to be appended with new sample data, allowing samples to be accumulated.

   b. Software to be included that is capable of graphing the trend logged object data. Software capable of creating two-axis (x,y) graphs that display object values relative to time.

   c. Operator able to change trend log setup information. This includes the information to be logged as well as the interval at which it is to be logged. Input, output, and value object types in the system may be logged. Provide operations password protected. Setup and viewing may be accessed directly from any graphics on which object is displayed.

   d. BAS Contractor to enable trending for any system points (physical or virtual) as directed by the Engineer, Owner or Commissioning Authority (Commissioning Authority). There will be no limit on the number of trended points the BAS Contractor is to set up. BAS Contractor will modify trend setup parameters as directed by the Commissioning Authority during testing. BAS Contractor to be proactive and enable trending for major system points during system startup/programming. BAS Contractor is not to wait for direction to begin trending points. Trend data for each point to be archived on the main server for a minimum of one year. Trend data archiving to be enabled immediately upon trend setup, or as soon as communication between the field panel and sever is established. Trend data uploads from field panel to server set up to be automatically performed with sufficient frequency to ensure no data gaps or loss of trend data.

   e. Trend points as identified in the points list. Provide system specific trend data in two-axis (x,y) graphs that display object values relative to time to Engineer, Owner, or Commissioning Authority.

8. Standard Reports: Standard system reports provided for this project. Provide ability for Owner to readily customize these reports for this project:

a. Objects: System (or subsystem) objects and their current values.

b. Logs:

1) Alarm History

2) System Messages

3) System Events

4) Trends

E. Interfaces to Third Party Systems: BAS connects to third party systems (VFDs, chillers, emergency generators, rooftop AC units, etc.). Communication protocol specified for third party system, and BAS provides compatible protocol to assure proper two way communication. Points, alarms, and commands displayed on BAS as indicated.

F. Workstation Applications Editors: Each PC workstation supports editing of system applications, which downloaded and executed at one or more controller panels.

2.4 CONTROLLER SOFTWARE

A. Furnish following applications software for building and energy management. Software applications reside and operate in system controllers. Software to be manufacturer's most current version at the time of installation. Software and associated functions (scheduling, optimum start/stop, etc.) noted in this specification are to be configured and enabled for this project. Incorporate into sequence of operation submittals for review prior to installation.

B. System Security:

1. User access secured using individual security passwords and user names.

2. Restrict user passwords to objects, applications, and system functions as assigned by system manager. Provide monitoring only access to Engineer of Record and Commissioning Authority for period of one year for trouble shooting purposes.

3. Record user Log On/Log Off attempts.

4. Provide passwords, user names, and access assignments adjustable at the operator's terminal. Each user to have a set security level, which defines access to displays and individual objects the user may control. System to include 10 separate and distinct security levels for assignment to users.

5. System to include an Auto Logout Feature that will automatically logout user when there has been no keyboard or mouse activity for a set period of time. Time

period to be adjustable by system administrator. Auto Logout may be enabled and disabled by system administrator. Operator terminal to display message on screen that user is logged out after Auto Logout occurs.

C. Scheduling: Provide capability to schedule each object or group of objects in system. Coordinate schedule with Owner and program accordingly. Each schedule consists of:

1. Operator's workstation to show information in easy-to-read daily format. Priority for scheduling: Events, holidays and daily with events being the highest.

2. Holiday and special event schedules to display data in calendar format. Operator able to schedule holidays and special events directly from these calendars.

3. Operator able to change information for a given weekly or exception schedule if logged on with the appropriate security access.

D. Optimum Start/Stop: Provide software and program system to start equipment on sliding schedule based upon indoor and outdoor conditions. Determine minimum time of HVAC system operation needed to satisfy space environmental requirements and also determine earliest possible time to stop mechanical systems (i.e. shut down cooling/heating and only provide ventilation one hour prior to scheduled unoccupied period.). Optimum start/stop program operates in conjunction with scheduled start/stop and night setback programs.

E. Alarms:

1. Operator's workstation to provide visual means of alarm indication. The alarm dialog box to always become the top dialog box regardless of the application(s), currently running.

2. System to provide log of alarm messages. Alarm log to be archived to the hard disk of the system operator's terminal. Each entry to include a description of the event-initiating object generating the alarm. Entry to include time and date of alarm occurrence.

3. Alarm messages in user-definable text and entered either at the operator's terminal or via remote communication.

4. Each binary object set to alarm based on operator-specified state.

5. Each analog object have both high and low alarm limits.

6. Alarms must be able to be automatically and manually disabled.

7. Alarms are routed to appropriate workstations based on time and other conditions. An alarm is able to start programs, print, be logged in event log, generate custom messages, and display graphics.

8. System have ability to dial out in event of alarm.

9. Alarm Levels:

   a. Provide 5 levels of alarm as follows, and program alarm levels for every required and specified alarm:

      1) Level 1: Critical/life safety.

      2) Level 2: Significant equipment failure.

      3) Level 3: Non-critical equipment failure/operation.

      4) Level 4: Energy conservation monitor.

      5) Level 5: Maintenance indication, notification.

   b. Prior to training of Owner's Authorized Representative, submit the complete Points List and suggested Alarm Levels to the Owner.

   c. During training of Owner's Authorized Representative(s):

      1) Discuss Alarm Levels and the alarms currently included in the BAS.

      2) Provide additional alarms without addition of new hardware points, as required by Owner's Authorized Representative.

      3) Agree with the Owner's Authorized Representative on action(s) to be taken for each alarm level and implement same for each alarm. Said action to include visual and/or audible alarm(s) at the Operator workstation including whether Operator acknowledgement is required or not, email messages, and text messages.

F. Demand Limiting:

1. System to include demand limiting program that includes two types of load shedding. One type of load shedding to shed/restore equipment in binary fashion based on energy usage when compared to shed and restore settings. The other type of shedding to adjust operator selected control setpoints in an analog fashion based on energy usage when compared to shed and restore settings. Shedding may be implemented independently on each and every zone or piece of equipment connected to system.

2. Status of each and every load shed program capable of being displayed on every operator terminal connected to system. Status of each load assigned to an individual shed program displayed along with the description of each load.

3. Demand-limiting program monitor building power consumption from signals generated by pulse generator (provided by BAS contractor) mounted at building power meter or from watt transducer or current transformer attached to building feeder lines.

4. Demand-limiting program predicts probable power demand so that when demand exceeds demand limit, action will be taken to reduce loads in predetermined manner. When demand limit will not be exceeded, action will be taken to restore loads in predetermined manner.

G. Maintenance Management: System monitors equipment status and generate maintenance messages based upon user-designated run-time, starts, and/or calendar date limits. Coordinate settings with Owner.

H. Sequencing: Provide application software based upon sequences of operation specified to properly sequence designated systems. Provide points to achieve specified sequences.

I. Staggered Start: This application prevents controlled equipment from simultaneously restarting after a power outage. Order in which equipment (or groups of equipment) is started, along with time delay between starts to be user-selectable.

J. Energy Calculations: Provide software to allow instantaneous power (e.g. kW) or flow rates (e.g. L/s (gpm)) to be accumulated and converted to energy usage data.

K. Anti-Short Cycling: Binary output objects protected from short cycling by allowing minimum on-time and off-time to be selected.

L. On/Off Control with Differential: Provide algorithm that allows binary output to be cycled based on controlled variable and setpoint. Algorithm direct-acting or reverse-acting and incorporate adjustable differential.

M. Run-Time Totalization: Provide software to totalize run-times for binary input objects.

2.5 WEB BASED ACCESS

A. General Description: BAS supplier to provide web-based access to the system as part of standard installation. Provide access to user of displays of real-time data that are part of the BAS via a standard Web browser. Web browser to tie into the network via Ethernet network connection. Provide web-page host that resides on the BAS network. Web-page software not to require a per user licensing fee or annual fees.

The web-page host must be able to support at least 50 simultaneous users with the ability to expand the system to accommodate an unlimited number of users. Software to be manufacturer's most current version at time of installation.

B. Browser Technology: Browser to be standard version of Microsoft Internet Explorer (latest edition). No special vendor-supplied software needed on computers running browser. Displays viewable and the Web-page host to directly access real-time data from the BAS network. Data displayed in real time and update automatically without user interaction. User able to change data on displays if logged in with the appropriate user name and password.

C. Display of Data: Web page graphics shown on browser to be replicas of the BAS displays. User to need no additional training to understand information presented on Web pages when compared to what is shown on BAS displays. Web page displays to include animation just as BAS displays. Fans to turn, pilot lights to blink, and coils to change colors, and so on. Real-time data shown on browser Web pages. This data must be directly gathered via the BACnet network and automatically updated on browser Web page displays without any user action. Data on the browser to automatically refresh as changes are detected without re-drawing the complete display. User to be able to change data from browser Web page to if the user is logged on with the appropriate password. Clicking on a button or typing in a new value to change digital data. Using pull-down menus or typing in a new value to change analog data. Data displays navigated using pushbuttons on the displays that are simply clicked on with the mouse to select a new display. Alternatively, the standard back and forward buttons of the browser can be used for display navigation.

D. Web Page Generation: Web pages generated automatically from the BAS displays that reside on the BAS server. User to access Web-page host via the network and initiate a web page generation utility that automatically takes the BAS displays and turns them into Web pages. The Web pages generated are automatically installed on the Web page host for access via any computer's standard browser. Any system that requires use of an HTML editor for generation of Web pages will not be considered.

E. Password Security and Activity Log: Access via Web browser to utilize the same hierarchical security scheme as BAS system. User asked to log in once the browser makes connection to Web-page host. Once the user logs in, any changes that are made to be tracked by the BAS system. User able to change only those items that the user has authority to change. A user activity report to show any activity of the users that have logged in to the system regardless of whether those changes were made using a browser or via the BAS workstation.

F. Communication: Web-page host to communicate using the specified protocol standard to devices on the BAS network.

2.6 BAS GRAPHICS

A. Develop customized graphics showing the project building(s) and their floor plans, mechanical, and electrical equipment, flow and control diagrams, and other relevant features on Workstation graphic screens. Associated input, output, and virtual objects (e.g., temperature and pressure setpoints) listed in the Sequence of Operation, and shown on the Input/Output Objects List included in the graphic screens and bound to the database. Real-time value of objects updated on the display of each graphic automatically. For projects where existing campus and/or building controls systems exist, replicate graphics used in the existing BAS graphics screens.

B. Graphics to have links to the Print function and to display a Standard Legend in the corner of the graphic. Graphics, except pop-ups, to have the date and time displayed in the upper corner of the graphic. Each graphic titled.

C. Weather: Graphics, except pop-ups, to have the outdoor temperature and humidity in the upper corner of the graphic.

D. Alarms: System and component summary alarms located near the top of each relevant graphic screen. Provide links to the associated system/component as part of these tags to assist trouble shooting. Other alarms placed near the associated system/device as depicted in the graphic. Provide text and color of information tags that describe each object and alarm value consistent with a graphics color legend.

E. The Following Graphics Provided as a Minimum:

1. A building graphic, typically a photograph of the building, with links to each floor plan and other links as defined below.

2. Central equipment such as air handler, package rooftop equipment, supply fans, exhaust fans, and smoke control systems.

3. Floor plans of each floor, with temperature sensors, pressure sensors, temperature control zones, heating/cooling zones, ventilation zones, and supply air zones identified. Rooms grouped on a graphic only to the extent that detailed and complete sensing information can be comfortably viewed by an operator and the bound points updated in less than 10 seconds. Each zone to have a temperature symbol that changes color over the range from low (blue) through normal (green) to high (red) and indicate an alarm (flashing red). The zone temperature and or pressure symbol(s) to be a link to a zone control pop-up graphic. Individual floor plan graphics to provide links to related mechanical systems. The mechanical room plan graphics to show the relative location of, and

provide links to, either the equipment pop-up or flow and control graphic for mechanical equipment monitored or controlled by the BAS.

4. Pop-up graphics provided for each zone control system showing a flow diagram and related monitoring and control points and system parameters. Pop-up graphics provided for each piece of equipment that is not shown on a flow and control graphic.

5. Flow and control diagrams for each system including but not limited to fan coils, generators, packaged equipment, and ventilation systems. The flow and control graphics to have parameters grouped in the lower portion of the graphics. Standard equipment graphics used. Pumps, fans, dampers and other elements to dynamically indicate their state (i.e. pumps and fans to rotate when on and damper positions to dynamically adjust and be shown in their current position, etc.). System flow and control graphics displayed in a general left to right flow or loop arrangement. Return and exhaust air flow shown on top and return water shown on the bottom of the graphic.

6. Individual equipment/component screens showing sensing and control information available for each device provided.

F. Penetration: The graphic interface to consistently apply a convention whereby a left-click to always penetrate to more detailed information. The text windows to represent the deepest level of penetration. A right-click to always produce a menu of options that are specific to the item selected.

G. Navigation: Graphics organized to provide a "branching structure" that allows an operator to move from a "macro view" to a "micro view" and return. These links to other associated graphics, or allow a return to a previous macro view, provided and arranged horizontally along the bottom of each graphic screen. From left to right, the graphic links as follows: site/building map, building/trailer floor plans, and major mechanical systems at each building. Pop-up right click menus provided as needed on the lower button bar to allow for uncluttered navigation.

H. Clutter Minimization: Each graphic to have separate check boxes in the lower right corner that show/hide setpoints, alarms/safeties, and devices/equipment.

I. Templates: To the maximum extent possible, use standard graphics as templates to provide a consistent look throughout the interface.

J. Color Scheme: The graphics to use dynamic color changes to communicate equipment type, or object status consistent with the graphics color legend.

K. Symbols and Animations: Fans, pumps, dampers, coils, and generation equipment to be dynamic symbols indicating rotation, state, or position, movement, flow, etc.

L. Macros: When macros are used to add functionality to the graphics, detailed documentation provided.

M. Configure Mode: Access to "Configure Mode" for editing of the graphics password protected to prevent unauthorized changes to the graphics. This password supplied to the appropriate personnel.

N. Graphics Version: Graphics provided in the most current format available at time of control system programming.

O. Points and graphics checked for the proper binding and graphic programming, settings to ensure that the correct system, location, point values and dynamics are shown in the proper location and rotate in the proper directions.

P. After graphics have been accepted, provide, on a CD ROM in an agreed upon file structure. If the graphics have active-x controls or other files that must be placed outside the graphics folder structure a set-up program provided on the disk to place the files in the correct locations.

2.7 BUILDING CONTROLLERS

A. General: Provide adequate number of building controllers to achieve performance specified. Panels to meet the following requirements.

1. Building Automation System (BAS) to be composed of one or more independent, stand-alone, microprocessor-based building controllers to manage global strategies described in Controller Software article.

2. Provide sufficient memory to support operating system, database, and programming requirements.

3. Share data between networked building controllers.

4. Distributed controllers to share real and virtual object information and allow for central monitoring and alarms.

5. Controllers that perform scheduling have real-time clock.

6. Continually check status of its processor and memory circuits and if abnormal operation is detected, controller:

a. Assume predetermined failure mode.

b. Generate alarm notification.

7. Building Controller communicates with other devices on internetwork including BACnet communications according to specified protocol.

B. Communication:

1. Each building controller resides on network using ISO 8802-3 (Ethernet) Data Link/Physical layer protocol and performs routing to network of custom application and application specific controllers.

2. Controller provides a service communication port for connection to a portable operator's terminal.

C. Environment:

1. Controllers used outdoors and/or in wet ambient conditions mounted within NEMA waterproof enclosures and rated for operation at 0 degrees F to 150 degrees F.

2. Controllers used in conditioned space are mounted in NEMA dust-proof enclosures and rated for operation at 32 degrees F to 120 degrees F.

D. Keypad: Local keypad and display to be provided for each controller. Security password to be available to prevent unauthorized use of keypad and display.

E. Serviceability: Provide diagnostic LEDs for power, communication, and processor. Wiring connections are made to modular terminal strips or to termination card connected by ribbon cable.

F. Memory: Building controller maintains BIOS and programming information in event of power loss for at least 72 hours.

G. Immunity to power and noise. Controller able to operate at 90 percent to 110 percent of nominal voltage rating and performs an orderly shutdown below 80 percent nominal voltage. Operation protected against electrical noise of 5 to 120 Hz and from keyed radios up to 5 W at 3-feet.

H. Controller to have a battery to provide power for orderly shutdown of controller and storage of data in nonvolatile flash memory. Battery backup to maintain real-time clock functions for a minimum of 10 days.

2.8 APPLICATION SPECIFIC CONTROLLERS

A. Application specific controllers (ASCs) are microprocessor-based DDC controllers, which through hardware or firmware design are dedicated to control a specific piece of equipment. Controllers to be fully programmable using graphical programming blocks.

1. ASC controllers communicate with other devices on internetwork.

2. Each ASC capable of stand-alone operation without being connected to network.

3. Each ASC will contain sufficient I/O capacity to control target system.

4. Application controllers to include universal inputs with minimum 10-bit resolution that accept thermistors, 0-10VDC, 0-5 VDC, 4-20 mA and dry contact signals. Any input on a controller may be either analog or digital with at least 1 input that accepts pulses. Controller to also include support and modifiable programming for interface to intelligent room sensor with digital display. Controller to include binary and analog outputs on board. Provide analog outputs switch selectable as either 0-10VDC or 0-20mA. Software to include scaling features for analog outputs. Application controller to include 24VDC voltage supply for use as power supply to external sensors.

5. Program sequences stored on board application controller in EEPROM. No batteries needed to retain logic program. Program sequences executed by controller 10 times per second and capable of multiple PI and PID loops for control of multiple devices. Calculations completed using floating-point math and system to support display of information in floating-point nomenclature at operator's terminal. Programming of application controller completely modifiable in the field over installed BAS LANs or remotely via modem interface. Operator to program logic sequences by graphically moving function blocks on screen and tying blocks together on screen.

6. Application controller to include support for room sensor. Display on room sensor programmable at application controller and include an operating mode and a field service mode. Provide button functions and display data programmable to show specific controller data in each mode based on which button is pressed on the sensor. See sequence of operation for specific display requirements at intelligent room sensor.

B. Communication:

1. Controller resides on network using MS/TP Data Link/Physical layer protocol.

2. Each controller connected to building controller.

3. Each controller capable of connection to laptop computer or portable operator's tool.

C. Environment:

1. Controllers used outdoors and/or in wet ambient conditions mounted within NEMA waterproof enclosures and rated for operation at 0 degrees F to 150 degrees F.

2. Controllers used in conditioned space mounted in NEMA dust-proof enclosures and rated for operation at 32 degrees F to 120 degrees F.

D. Serviceability: Provide diagnostic LEDs for power, communication, and processor.

E. Memory: ASC use nonvolatile memory and maintains BIOS and programming information in event of power loss.

2.9 ADVANCED APPLICATION CONTROLLERS

A. General:

1. Expandable application controller capable of providing control strategies for the system based on information from any connected inputs. Provide program implementing these strategies completely flexible and user definable. Provide program execution of controller a minimum of once per second.

2. Programming: Object-oriented using control program blocks. Controller to support a minimum of 500 Analog Values and 500 Binary Values. Each and every analog and binary value to support standard specified protocol priority arrays.

3. Provide means to graphically view inputs and outputs to each program block in real-time as program is executing. This function may be performed via the operator's terminal or field computer.

4. Controller to have adequate data storage to ensure high performance and data reliability. Battery to retain static RAM memory and real-time clock functions for a minimum of 1.5 years (cumulative). Provide field-replaceable battery (non-rechargeable) lithium type. Unused battery life: 10 years.

5. The onboard, battery-backed real time clock must support schedule operations and trend logs.

6. Global control algorithms and automated control functions should execute via 32-bit processor.

7. Controller to include both on-board Ethernet specified protocol communication over twisted pair cable (UTP) and to include specified protocol IP communication. In addition, controller to include specified protocol PTP connection port.

8. The base unit of the controller to host up to 8 expansion modules with various I/O combinations. These inputs and outputs to include universal 12-bit inputs, binary triac outputs, and 8-bit switch selectable analog outputs (0-10V or 0-20 mA). Inputs to support thermistors, 0-5VDC, 0-10VDC, 4-20mA, dry contacts and pulse inputs directly.

9. Outputs must have onboard Hand-Off-Auto switches and a status indicator light. HOA switch position to be monitored. Each analog output to include a potentiometer for manually adjusting the output when the HOA switch is in the Hand position.

10. The position of each and every HOA switch to be available system wide as a specified protocol object. Expandable Controller to provide up to 176 discreet inputs/outputs per base unit.

B. Schedules: Each controller to support a minimum of 50 Schedule Objects.

C. Logging Capabilities: Each controller to support a minimum of 200 trend logs. Any object in the system (real or calculated) may be logged. Sample time interval adjustable at the operator's workstation.

D. Alarm Generation:

1. Alarms may be generated within the system for any object change of value or state either real or calculated. This includes things such as analog object value changes, binary object state changes, and various controller communication failures.

2. Alarm log provided for alarm viewing. Log may be viewed on-site at the operator's terminal or off-site via remote communications.

3. Controller must be able to handle up to 200 alarm setups stored as event enrollment objects - system destination and actions individually configurable.

2.10 INPUT/OUTPUT INTERFACE

A. Input/output points protected such that shorting of point to itself, to another point, or to ground will cause no damage to controller. Input and output points protected from voltage up to 24 V.

B. Binary inputs (BI or DI) allow monitoring of On/Off signals from remote devices. Binary inputs sense “dry contact” closure without external power (other than that provided by controller) being applied.

C. Pulse accumulation input objects accept up to 10 pulses per second for pulse accumulation.

D. Analog inputs (AI) allow monitoring of low-voltage (0 to 10 VDC), current (4 to 20 mA), or resistance signals (thermistor, RTD).

E. Binary outputs (BO or DO) provide for On/Off operation or pulsed low-voltage signal for pulse width modulation control. Binary outputs on building and custom application controllers have three-position (On/Off/Auto) override switches and status lights. Outputs selectable for either normally open or normally closed operation.

F. Analog outputs (AO)provide a modulating signal for control of end devices. Outputs provide either a 0 to 10 VDC or a 4 to 20 mA signal as required to provide proper control of the output device. Analog outputs on building controllers have status lights and two-position (AUTO/MANUAL) switch and adjustable potentiometer for manual override. Analog outputs not exhibit drift of greater than 0.4 percent of range per year.

G. Tri-State Outputs. Provide tri-state outputs (two coordinated binary outputs) for control of three-point floating type electronic actuators without feedback. Use of three-point floating devices limited to zone control and terminal unit control applications (VAV terminal units, duct-mounted heating coils, zone dampers, radiation, etc.). Control algorithms run zone actuator to one end of its stroke once every 24 hours for verification of operator tracking.

2.11 POWER SUPPLIES AND LINE FILTERING

A. Control transformers UL listed. Furnish Class 2 current-limiting type or furnish over-current protection in both primary and secondary circuits. Limit connected loads to 80 percent of rated capacity.

B. DC power supply output match output current and voltage requirements. Unit operates between 32 degrees F and 120 degrees F.

C. Line voltage units UL listed and CSA approved.

D. Power line filtering. Provide transient voltage and surge suppression for workstations and controllers.

2.12 CONTROL PANELS

A. Control Panels:

1. Enclosures may be NEMA 1 when located in a clean, dry, indoor environment. Indoor enclosures to be NEMA 12 when installed in other than a clean environment. Outdoor enclosures must be NEMA 3R. Provide (hinged door) key-lock latch and removable subpanels. Single key common to field panels and subpanels. In existing campus or building settings, key lock to match existing keys.

2. Interconnections between internal and face-mounted devices prewired with color-coded stranded conductors neatly installed in plastic troughs and/or tie-wrapped. Terminals for field connections UL listed for 600 volt service, individually identified per control/ interlock drawings, with adequate clearance for field wiring. Control terminations for field connection individually identified per control drawings.

3. Provide ON/OFF power switch with overcurrent protection for control power sources to each local panel.

4. Provide laminated plastic nameplates for enclosures in any mechanical room or electrical room labeled with TCP number. Laminated plastic to be 1/8-inch thick sized appropriately to make label easy to read.

2.13 AUXILIARY CONTROL DEVICES

A. Temperature Instruments:

1. Low-voltage or Line-voltage Thermostats: Bimetal-actuated, snap acting SPDT contact, enclosed, UL listed for electrical rating, exposed setpoint adjustment on cover with heat anticipator. Thermostat operates within 55 degrees F to 85 degrees F setpoint range, with 2 degrees F maximum differential.

2. Probe Duct Temperature Sensors: Thermistor or platinum RTD element with accuracy of plus or minus 0.5 degrees F at 32 degrees F, consisting of single point sensing elements, securely mounted in duct or plenum; operating range 20-120 degrees F; linear signal; 24-inch rigid probe. Use where duct is less than 9 SF cross-sectional area.

3. Outside Air Temperature Sensor: Thermistor or platinum RTD element with accuracy of plus or minus 0.5 degrees F at 32 degrees F; Range -58 to 120 degrees F, single element, linear, with weather and sun shield for exterior mounting.

B. Pressure Transmitters and Transducers:

1. Transducer have linear output signal; field adjustable zero and span. Sensing elements withstand continuous operating conditions of positive or negative pressure 50 percent greater than calibrated span without damage.

2. Differential Pressure Switch: Setpoint adjustable with operating range of 0.5 to 12-inch WG for fans, and 5 to 30-feet WC for pumps. Switches UL listed; SPDT snap-acting; pilot duty rated (125 VA minimum); NEMA 1 enclosure; scale range and differential suitable for intended application.

3. Duct Static Differential Pressure Transducer: Operating range 0 to 5-inch WC for duct mounted transmitter; ceramic capacitive sensing element with probe securely mounted in duct; digital input terminal and push button to zero output. Accuracy plus or minus 1 percent of full scale; maximum response time 2 seconds.

4. Building Static Pressure Transducer: Operating range of -0.1 to 0.1-inch WC, linear signal. Sensing tubes located inside and outside building use shielding and/or surge tanks to minimize effects of wind. Accuracy plus or minus 1 percent of full scale.

5. Piping Pressure Transmitter: Operating range 0 to 50 PSIG, linear signal; stainless steel diaphragm; digital input terminal and push button to zero output. Accuracy plus or minus 1 percent of full scale.

C. Electric Damper Actuators:

1. Provide mechanical or electronic stall protection for each actuator.

2. Where indicated provide internal mechanical, spring-return mechanism or provide uninterruptible power supply (UPS). Non-spring-return actuators have external manual gear release to position damper/valve when actuator is not powered.

3. Proportional actuators accepts 0 to 10 VDC or 0 to 20 mA control signal and provide 2 to 10 VDC or 4 to 20 mA operating range.

4. Actuator sized for torque required plus 25 percent; UL or CSA listed; electronic current overload protection.

D. Duct Mounted Carbon Dioxide Sensor:

1. Duct mounted CO2 sensor consists of infrared sensing element with heated stannic dioxide semiconductor. Operating range 0-2000 ppm plus 50 ppm plus 2 percent of measured value; maximum duct velocity of 1500 fpm; duct mounting kit.

E. Wall Mounted Space Carbon Dioxide Sensor:

1. Sensor to employ non-dispersive infrared technology. (N.D.I.R.)

2. Sensor Repeatability: Plus or minus 20 ppm. 0-2000.

3. Sensor Accuracy: Less than or equal to 75 ppm over 0-1500 ppm range.

4. Sensor Response Time: Less than 1 minute.

5. Sensor to employ reference channel design for long-term stability.

6. Sensor to have field selectable 0-10VDC, or 4-20mA outputs.

7. Sensor power requirement less than 3W.

8. Sensor Input Voltage: 20 to 30VAC/DC.

9. Sensor Operating Temperature Range: 0 degrees C to 50 degrees C.

10. Sensor to have models for wall mounting or duct mounting.

11. Sensor to provide at least a 1-year factory warranty from date of purchase.

12. Sensor to match cover in color and look to temperature sensor.

13. Sensor to have display.

14. Manufacturers:

    a. Telaire

    b. Vaisala

    c. Veris

F. Carbon Monoxide Detector:

1. Microprocessor based CO sensor and controller with fan relay, pilot light indicators; comply with UL Standards 2034; self-supervision activates fan if system detects problems; calibration kit for project.

2. Relay to activate fan at sensing 35 ppm CO after 5 minutes. Minimum fan runtime to be 2-1/2 minutes. Relay to activate alarm at sensing 100 ppm CO after 30 minutes. Vulcain Electrochemical Type (Q1).

G. Nitrogen Dioxide Detector:

1. Microprocessor based NO2 sensor and controller with fan relay, pilot light indicators; comply with UL Standards 2034; self-supervision activates fan if system detects problems; calibration kit for project.

2. Relay to activate fan at sensing 10 PPM NO2 after 5 minutes. Minimum fan runtime to be 2-1/2 minutes. Relay to activate alarm at sensing 15 PPM NO2 after 30 minutes. Vulcain Electrochemical Type (Q1).

H. Occupancy Sensor: Dual technology infrared and ultrasonic sensing device, ceiling or wall mounted, built-in self-adjusting settings, timer settings of 30 seconds to 30 minutes, with manual and automatic modes. Provide multiple devices in parallel when area served is greater than a single device sensing capability. Provide integral power pack, 120 VAC input, 24 VDC output, with manual override switch. Leviton OSC-MOW series.

I. Relays:

1. Control relays UL listed plug-in type with dust cover and LED “energized” indicator. Contact rating, configuration, and coil voltage to be suitable for application.

2. Time delay relays UL listed solid-state plug-in type with adjustable time delay. Delay adjustable plus or minus 200 percent (minimum) from setpoint or as indicated. Contact rating, configuration, and coil voltage to be suitable for application. Provide NEMA 1 enclosure when not installed in local control panel.

J. Override Timers: Override timers spring-wound line voltage, UL Listed, with contact rating and configuration as required by application. Provide 0-to-6-hour calibrated dial unless otherwise specified. Timer suitable for flush mounting on control panel face and located on local control panels or where shown.

K. Current Transmitters:

1. AC current transmitters are self-powered, combination split-core current transformer type with built-in rectifier and high-gain servo amplifier with 4 to 20 mA two-wire output. Unit range compatible with actual applied span of current value, with internal zero and span adjustment and plus or minus 1 percent full-scale accuracy at 500 ohm maximum burden.

2. Transmitter meets or exceeds ANSI/ISA S50.1 requirements and UL/CSA recognized.

3. Unit split-core type for clamp-on installation on existing wiring.

L. Voltage Transformers: AC voltage transformers UL/CSA recognized, 600 VAC rated; built-in fuse protection; suitable for ambient temperatures of 40 degrees F to 130 degrees F; plus or minus 0.5 percent accuracy at 24 VAC and a 5 VA load.

M. End Switches: Turret head Type SPDT. Schneider Electric/Square D Class 9007, Type C54B2, or approved equivalent.

2.14 WIRING AND RACEWAYS

A. General: Provide copper wiring, plenum cable, and raceways as specified in applicable Sections of Division 26, Electrical.

B. Insulated wire to be copper conductors, UL labeled for 90 degrees C minimum service.

C. Field panels and controllers to be supplied by building emergency power system where systems being monitored or controlled are on emergency power.

D. Run control wiring as follows:

1. Mechanical Rooms: In conduit.
2. Exposed in Building Spaces: In conduit.
3. Concealed in Building Walls and Ceilings: Plenum rated cable.
4. Concealed in Building Ceilings: Plenum rated cable in cable tray.

E. Field and Subfield Panels: Voltage in panels not-to-exceed 120 volts.

F. Motor Control Centers: Responsibility for correct voltage of holding coils and starter wiring in pre-wired motor control centers interfacing with automatic controls is included hereunder.

G. Wiring for BAS systems communications buses two conductor minimum 18 gauge foil-shielded, stranded twisted pair cable rated at 300 VDC or more than 80 degrees C.

2.15 SMOKE DETECTION (FOR BUILDINGS WITH A FIRE ALARM SYSTEM)

A. See Division 28 for Products.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Prior to starting work, carefully inspect installed work of other trades and verify that such work is complete to the point where work of this Section may properly commence.

B. Notify the Owner's Authorized Representative in writing of conditions detrimental to the proper and timely completion of the work.

C. Do not begin work until unsatisfactory conditions are resolved.

3.2 CONTROL SYSTEM CHECKOUT AND TESTING

A. Testing completed before Owner's Authorized Representative is notified of system demonstration.

B. Calibrate and prepare for service of instruments, controls, and accessory equipment furnished under this specification.

C. Verify that control wiring is properly connected and free of shorts and ground faults.

D. Enable control systems and verify calibration and operation of input and output devices.

E. Verify that system operation adheres to sequences of operation.

F. Commissioning and Verification: In addition to commissioning requirements specified elsewhere, provide the following commissioning on the HVAC instrumentation and controls system:

1. Control systems completely commissioned to ensure aspects of the system are operating as intended and at optimum tuning.
2. Wiring connections verified and traced from field device to panel to ensure proper connections.
3. Measured values verified by a hand held calibrated device to validate that value indicated by the control system is in fact the actual measured value.
4. Loops properly tuned to obtain the desired control value. Each loop to be "upset" and put back in control to demonstrate its ability to stabilize quickly.
5. Provide a final point-by-point report submitted that indicates the date of each verification, the results, and initialed on each page by the person performing the reading.

3.3 ACCEPTANCE TESTING AND TRAINING

A. Site Testing:

1. Contractor provides personnel, equipment, instrumentation, and supplies necessary to perform testing. Owner or Owner's Authorized Representative will witness and sign off on acceptance testing.

2. Contractor demonstrates compliance of completed control system with Contract Documents. Using approved test plan, physical and functional requirements of project demonstrated.

B. Training:

1. General: Contractor conducts training courses for up to three other designated personnel in operation and maintenance of system. Training manuals provided for each trainee, with two additional copies provided for archival at project site. Manuals include detailed description of subject matter for each lesson. Copies of audiovisuals delivered to Owner. Training day is defined as 8 hours of classroom instruction, including two 15-minute breaks and excluding lunch time, Monday through Friday, during normal first shift in effect at training facility. Notification of any planned training given to Owner's Authorized Representative at least 15 days prior to training.

2. Operator's Training I: First course taught at supplier's facility for period of one training day. Upon completion, each student should be able to perform elementary operations with guidance and describe general hardware architecture and functionality of system.

3. Operator's Training II: Second course taught at project site for a period of one training day after completion of contractor's field testing. Course includes instruction on specific hardware configuration of installed system and specific instructions for operating installed system. Upon completion, each student should be able to start system, operate the system, recover system after failure, and describe specific hardware architecture and operation of system.

4. Operator's Training III: Third course taught at project site for period of one training day no later than six months after completion of the acceptance test. Course will be structured to address specific topics that students need to discuss and to answer questions concerning operation of system. Upon completion, students should be fully proficient in system operation and have no unanswered questions regarding operation of installed system.

3.4 COMMUNICATION WIRING

A. Follow manufacturer's installation recommendations for communication cabling.

B. Verify integrity of network following cable installation.

C. Communication wiring unspliced length when that length is commercially available; labeled to indicate origination and destination data.

D. Grounding of coaxial cable in accordance with NEC regulations article on "Communications Circuits, Cable, and Protector Grounding."

3.5 WIRING AND RACEWAYS

A. Provide electrical wiring required to control systems specified in this Section. Control and interlock wiring complies with national, state and local electrical codes and Division 26, Electrical of this specification.

B. Power wiring required for building control panel(s) to be dedicated circuit(s).

C. Verify location of operator work station with Owner prior to installation.

D. NEC Class 1 (line voltage) wiring UL Listed in approved raceway according to NEC and Division 26, Electrical requirements.

E. Low-voltage wiring meets NEC Class 2 requirements. (Low-voltage power circuits subfused when required to meet Class 2 current limit.)

F. Where NEC Class 2 (current-limited) wires are in concealed and accessible locations, including ceiling return air plenums, approved cables not in raceway may be used provided that cables are UL listed for intended application.

G. Do not install Class 2 wiring in raceway containing Class 1 wiring. Boxes and panels containing high-voltage wiring and equipment may not be used for low-voltage wiring except for purpose of interfacing (e.g., relays and transformers).

H. Where Class 2 wiring is run exposed, wiring run parallel along surface or perpendicular to it and tied at 10 foot intervals.

I. Where plenum cables are used without raceway, support from structural members. Do not support cables with ductwork, electrical raceways, piping, or ceiling suspension systems.

J. Make wire-to-device connections at terminal block or terminal strip. Make wire-to-wire connections at terminal block.

K. Maximum allowable voltage for control wiring 24 V. If only higher voltages are available, provide step-down transformers.

L. Wiring installed as continuous lengths, with no splices permitted between termination points.

M. Install plenum wiring in sleeves where it passes through walls and floors. Maintain fire rating at penetrations.

N. Include one pull string in each raceway 1-inch or larger.

O. Control and status relays are to be located in designated enclosures. Enclosures include packaged equipment control panels unless they also contain Class 1 starters.

P. Install raceway to maintain a minimum clearance of 6-inches from high-temperature equipment (e.g., steam pipes or flues).

Q. Secure raceways with raceway clamps fastened to structure and spaced according to code requirements. Raceways and pull boxes may not be hung on flexible duct strap or tie rods. Raceways may not be run on or attached to ductwork.

R. Install insulated bushings on raceway ends and openings to enclosures. Seal top end of vertical raceways.

S. Flexible metal raceways and liquid-tight, flexible metal raceways not-to-exceed 3-feet in length and be supported at each end. In areas exposed to moisture, including chiller and boiler rooms, liquid-tight, flexible metal raceways to be used.

T. Raceway must be rigidly installed, adequately supported, properly reamed at both ends, and left clean and free of obstructions. Raceway sections joined with couplings. Terminations made with fittings at boxes.

U. Input and output terminations to be labeled at the controller to identify if they are AI, DI, AO, DO, and function (i.e. pump start, OM Sensor).

3.6 INSTALLATION OF AUXILIARY CONTROL DEVICES

A. General:

1. Install sensors and thermostats in accordance with manufacturer's recommendations.

2. Room sensors and thermostats installed at 48-inches AFF to midline of sensor on concealed junction boxes properly supported by wall framing at the locations shown on the Drawings.

3. Low-limit sensors used in mixing plenums installed in a serpentine manner horizontally across duct.

4. Pipe-mounted temperature sensors installed in wells with heat-conducting fluid in thermal wells.

5. Install outdoor air temperature sensors on north facing wall or screen, complete with sun shield at designated location.

B. Flow Switch: Use correct paddle for pipe diameter. Adjust flow switch in accordance with manufacturer's instructions.

C. Actuators:

1. General:

   a. Mount and link control damper actuators according to manufacturer's instructions.

   b. Check operation of damper/actuator combination to confirm that actuator modulates damper smoothly throughout stroke to both open and closed positions.

2. Actuator Mounting for Damper Arrangements to Comply with the Following:

   a. Damper Actuators: Do not install in the air stream.

   b. Use a weather proof enclosure (clear and see through) if actuators are located outside.

   c. Damper actuator ambient temperature not-to-exceed 122 degrees F through any combination of medium temperature or surrounding air. Provide appropriate air gaps, thermal isolation washers or spacers, standoff legs, or insulation as necessary. Mount per manufacturer's recommendations.

   d. Actuator cords or conduit to incorporate a drip leg if condensation is possible. Do not allow water to contact actuator or internal parts. Location of conduits in temperatures dropping below dew point to be avoided to prevent water from condensing in conduit and running into actuator.

   e. Damper mounting arrangements to comply with the following:

      1) Furnish and install damper channel supports and sheet metal collars.

      2) Jack shafting of damper sections not allowed.

      3) Multi-section dampers arranged so that each damper section operates individually. Provide one electronic actuator direct shaft mounted per section.

f. Size damper sections based on actuator manufacturers specific recommendations for face velocity, differential pressure and damper type. In general: Damper section not-to-exceed 24 ft-sq. with face velocity 1500 FPM.

g. Multiple section dampers of two or more arranged to allow actuators to be direct shaft mounted on the outside of the duct.

h. Multiple section dampers of three or more sections wide arranged with a 3-sided vertical channel (8-inch wide by 6-inch deep) within the duct or fan housing and between adjacent damper sections. Vertical channel anchored at the top and bottom to the fan housing or building structure for support. Connect sides of each damper frame to the channels. Holes in the channel to allow damper drive blade shafts to pass through channel for direct shaft mounting of actuators. Face open side of channel downstream of the airflow, except for exhaust air dampers.

i. Multiple section dampers to be mounted flush within a wall or housing opening to receive either vertical channel supports as described above or sheet metal standout collars. Sheet metal collars (12-inch minimum) to bring each damper section out of the wall to allow direct shaft mounting of the actuator on the side of the collar.

D. Control Damper:

1. Dampers installed in accordance with manufacturer's instructions. Unless specifically designed for vertical blade application, dampers must be mounted with blade axis horizontal.

2. After installation of low-leakage dampers with seals, caulk between frame and duct or opening to prevent leakage around perimeter of damper.

E. Air Flow Station: Install where indicated in ductwork and/or equipment with manufacturer's recommended straight ductwork upstream and downstream of air flow station or as shown on drawings, whichever is greater. Where equipment manufacturer's standard airflow measuring station cannot read airflows at required design velocities, provide appropriate air flow measuring station to provide accurate reading throughout system design operations range.

3.7 WATER DETECTOR

A. Mount by applying a silicone adhesive to the mounting feet. For more permanent installations, fasten the sensor using the 0.19-inch holes provided in the mounting feet with #6 or #8 screws.

B. Mount adjacent to area to be protected. Unroll the sensor tape, remove vinyl release layer from the back, and hand press onto surface that is dry and free of debris and dust.

1. Note 1: Once the sensor is activated (wet), the contacts will remain in alarm until the netted cover is completely dry.

2. Note 2: To convert the tape integrity check relay to a second alarm relay, remove the jumper in the lower right corner of the circuit board. If the sensing tape is not used, install the jumper labeled “NO TBL CHK.”

C. Mount by screwing or gluing to the floor or baseboard.

3.8 SMOKE DETECTION (FOR BUILDINGS WITH A FIRE ALARM SYSTEM)

A. Smoke detector furnished and powered/wired under Division 28, Electronic Safety and Security. Coordinate with fire alarm equipment supplier. Installation of duct smoke detector housing and sampling tube under Division 23, HVAC.

B. Install smoke detectors in return air systems greater than 2000 CFM.

3.9 SEQUENCES OF OPERATION AND POINTS LISTS

A. Where local energy code dictates certain sequences (such as night setback, night flush, pressure and temperature reset, terminal unit sequences, etc.), the sequences are not necessarily repeated in the documents. It is not the intent of this specification or documentation to reiterate the energy code. Provide energy code mandated sequences and document in sequence of operations submittals at no additional cost to the Owner. Provide required points to achieve the appropriate sequences.

B. Variable Frequency Drives: For a VFD dependent on an external input for its output setting (e.g., the VFD gets “Frequency” as an input), loss of that external input to result in the VFD holding its last value. If the VFD is running its own PID loop and the external input to the VFD is a setpoint (e.g. duct static pressure setpoint), the VFD to hold the last setpoint. If the VFD loses its process variable (e.g. duct static pressure), the VFD to go to its minimum speed setting.

C. Except as specified otherwise, throttling ranges, proportional bands, and cycle differentials to be centered on the associated setpoint. Modulating feedback control loops to include the capability of having proportional, integral, and derivative action. Unless the loop is specified “proportional only” or “P+I”, Contractor to apply appropriate elements of integral and derivative gain to each control loop to result in stable operation, minimum settling time and maintain the primary variable within the specified maximum allowable variance.

D. Provide a real time clock and schedule controller with sufficient scheduling capability to schedule required controllers and sequences. Schedule functionality may reside in a controller. If a controller is used, document scheduling functionality including names and types on controller points list submittal. Set up initial schedules in coordination with Owner.

E. Scheduling Terminology: When air handlers are scheduled throughout the day, the following defines the terminology used:

1. Occupied Period: Period of time when the building is in use and occupied. Confirm schedule with Owner. Exclude all national holidays. Generally systems will be fully operational throughout this period and ventilation air to be continuously introduced. Space temperature setpoints will generally be in the “normal” range of 68 degrees to 78 degrees F.

2. Unoccupied period: Period of time when the building or zone is not in use and unoccupied. Ventilation air not to be introduced.

3. Preoccupancy Period: Time prior to the Occupied period when the systems are returning the space temperatures from setback to “normal” or occupied setpoints (warm-up and cool-down). Ventilation air shall not be introduced unless outside air conditions permit free-cooling or to support a pre-occupancy purge sequence. Time period to be determined by an optimum start strategy unless otherwise specified.

4. Setback Period: Setback will typically start with the end of the occupied period and end with the start of the preoccupancy period, however it shall be provided with its own schedule. Generally systems will be off except to maintain a “setback” temperature, economization may be enabled to maintain “setback” cooling setpoint when applicable.

F. Where any sequence or occupancy schedule calls for more than one motorized unit to start simultaneously, the BAS start commands to be staggered by 5 second (adj.) intervals to minimize inrush current.

G. Wherever a value is indicated as adjustable (adj.), it shall be modifiable, with the proper password level. For these points, it is unacceptable to have to modify programming statements to change the setpoint.

H. When a power failure is detected in any phase, the BAS start commands to be retracted immediately from electrically powered units served by the failed power source. If the associated controller is powered by normal or emergency power, it may monitor its own power source as an indication of power status. If the controller is powered by uninterruptible power supply (UPS), or if it is not capable of monitoring its own power for use in sequences, provide at least one voltage monitor (three phase when applicable) per building. When the BAS detects that normal or emergency power has been restored, all equipment for which the BAS start command had been retracted to be automatically restarted in an orderly manner on staggered 5 second intervals to minimize inrush current.

I. Where reset action is specified in a sequence of operation, but a reset schedule is not indicated on the drawings, employ one of the following methods:

1. Determine a fixed reset schedule to result in stable operation and maintain the primary variable within the specified maximum allowable variance.

2. Use a floating reset algorithm which increments the secondary variable setpoint (setpoint of control loop being reset) on a periodic basis to maintain primary variable setpoint. The recalculation time and reset increment to be chosen to maintain the primary variable within the specified maximum allowable variance.

3. Primary variable to control the devices directly using a PID feedback control loop without resetting the secondary variable. However, the control devices to still modulate as necessary to maintain upper and lower limits on the secondary variable. Proportional band, integral gain, and derivative term to be selected to maintain the primary variable within the specified maximum allowable tolerance while minimizing overshoot and settling time. Gain prior approval for implementing this method of reset.

J. Where a supply air temperature or duct pressure setpoint is specified to be reset by the space temperature of the zones calling for the most cooling/heating, employ the following method:

1. Use a floating reset algorithm which increments the secondary variable (e.g., supply air temperature or duct pressure) setpoint on a periodic basis to maintain primary variable (e.g., space temperature) setpoint. The reset increment to be determined by the quantity of “need heat” or “need cool” requests from individual SCU's. A SCU's “need heat” virtual point to activate whenever the zone's space temperature falls below the currently applicable (occupied or unoccupied) heating setpoint throttling range. A SCU's “need cool” virtual point to activate whenever the zone's space temperature rises above the currently applicable (occupied, unoccupied, or economy) cooling setpoint throttling range. The recalculation time and reset increment to be chosen to maintain the primary variable within the specified maximum allowable variance while minimizing overshoot and settling time. Reset range maximum and minimum values to limit the setpoint range.

K. Where a supply air temperature, duct pressure, or differential water pressure setpoint is specified to be reset by valve or damper position of the zone or zones calling for the most cooling/heating, the following method to be employed:

1. A floating reset algorithm to be used which increments the secondary variable (e.g., supply air temperature, pipe or duct pressure) setpoint on a periodic basis to maintain primary variable (e.g., cooling valve, heating valve, damper position) setpoint of 85 percent open. The reset increment to be calculated based on the average position of the quantity of the worst (most open valve/damper) zone(s) as specified. The recalculation time, reset increment and control device position influence to be chosen to maintain the primal variable within the specified maximum allowable variance while overshoot and settling time. The BAS analog output value to be acceptable as indicating the position of the control device.

2. Alternatively to continuously calculating the average of the quantity of worst valve/damper positions, a method similar to the one described above may be employed whereby the “need heat” or “need cool” virtual point to increment by one unit each time a zone's valve/damper position rises to greater than 95 percent. The quantity of “need heat” or “need cool” points to then be the basis for reset.

L. Where “prove operation” of a device (generally controlled by a digital output) is indicated in the sequence, it shall require that the BAS, after an adjustable time delay after the device is commanded to operate (feedback delay), confirm that the device is operational via the status input. If the status point does not confirm operation after the time delay or anytime thereafter for an adjustable time delay (debounce delay) while the device is commanded to run, an alarm to be enunciated audibly. Upon failure, run command to be removed and the device to be locked out until the alarm is manually acknowledged unless specified otherwise.

M. BAS to provide for adjustable maximum rates of change for increasing and decreasing output from the following analog output points:

1. Speed control of variable speed drives

2. Control Reset Loop

3. Valve Travel Limit

N. Wherever a value is indicated to be dependent on another value (i.e., setpoint plus 5 degrees F) BAS to use that equation to determine the value. Simply providing a virtual point that the operator must set is unacceptable. In this case three virtual points to be provided. One to store the parameter (5 degrees F), one to store the setpoint, and one to store the value which is the result of the equation.

O. Trend points as identified in the points list. Trends to be grouped system specific and setup in two-axis (x,y) graphical format that display object values relative to time. Setup trends to record data in 5 minute increments.

END OF SECTION

SECTION 23 11 23 - FACILITY FUEL - NATURAL GAS PIPING AND SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Work Included:

1. Fuel Pipe and Pipe Fittings - General
2. Steel Pipe and Fittings, Above Grade
3. Natural Gas Valves
4. Gas Earthquake Valve
5. Natural Gas Pressure Regulators
6. Flexible Pipe Connectors - Gas Piping (CSA Listed)

1.2 RELATED SECTIONS

A. Contents of Division 23, HVAC and Division 01, General Requirements apply to this Section.

B. In addition, reference the following:

1. Division 26, Electrical requirements for grounding fuel piping systems.

1.3 REFERENCES AND STANDARDS

A. References and Standards as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.

1.4 SUBMITTALS

A. Submittals as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.

1.5 QUALITY ASSURANCE

A. Quality assurance as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements apply to this Section.

1.6 WARRANTY

A. Warranty of materials and workmanship as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Fuel Pipe and Pipe Fittings - General:

1. Flange Gaskets:

a. Buna-N (Nitrile)

b. NBR

c. Viton

d. Or approved equivalent.

B. Steel Pipe and Fittings, Above Grade:

1. American Piping Products

2. US Steel

3. Or approved equivalent.

C. Natural Gas Valves:

1. Apollo

2. Jenkins Bros.

3. Lunkenheimer Co.

4. Nibco

5. Watts

6. Or approved equivalent.

D. Gas Earthquake Valve:

1. California Valve

2. QuakeMaster

3. Or approved equivalent.

E. Natural Gas Pressure Regulators:

1. Maxitrol
2. Equimeter
3. Or approved equivalent.

F. Flexible Pipe Connectors - Gas Piping (CSA Listed):

1. Dormont
2. Proflex
3. Or approved equivalent.

2.2 FUEL PIPE AND PIPE FITTINGS - GENERAL

A. Flange Gaskets: Gaskets to be constructed from elastomeric materials.

B. Install per manufacturer's recommended installation requirements.

2.3 STEEL PIPE AND FITTINGS, ABOVE GRADE

A. Steel Pipe (Above Grade Installation):

1. ASTM A53, electric-resistance welded Type E, Grade B black pipe, manufactured for threaded pipe connections.
    a. 2-inches and Smaller: Schedule 40, ASTM A53 black steel pipe and black malleable threaded fittings.
    b. 2-1/2-inches and Larger: Schedule 40, ASTM A53 black pipe with butt weld fittings.

B. Fittings for Steel Pipe (Above Grade Installations):

1. General: Mark fittings, unions, and other products recognized as regularly available products in accordance with MSS SP-25. Marking on products of small size or shape may be omitted from sequence allowed by MSS SP-25, except for manufacturer's name or trademark.
2. Threaded Fittings: Conforming to ANSI B2.1, ASTM A47, 150 PSI rating, except where otherwise specified or prevailing codes or requirements dictate use of 300 PSI ratings. Fittings to be fabricated from standard malleable iron with dimensions conforming to ANSI B16.3.
3. Welded Fittings: Wrought carbon steel fittings, ASTM A234, ANSI B16.9, B16.28. Butt-welding type unless otherwise indicated to be socket welding type.

4. Flanges: Carbon steel conforming to ASTM A105, ANSI B16.5, and factory forged in USA. Flanges which have been machined, remade, painted, or are non-domestic origin are not acceptable. Provide raised or full face ends wherever indicated or required.

5. Flange Gaskets: Gaskets to be constructed from elastomeric materials.

6. Flange Hardware: Bolting materials to be corrosion resistant carbon steel bolts and hex nuts conforming to ASTM A307. Provide bolting materials used in containment sumps below grade applications, stainless steel bolts and hex nuts conforming to ASTM A453. Threads and dimensions to be in accordance with ANSI B1.1 and B18.2.

7. Unions: Conform to ANSI B16.39, ASTM A47 and fabricated from malleable iron with bronze-to-iron ground joints rated at 150 percent design operating pressure. Threads to conform to ANSI B2.1.

8. Threaded Pipe Plugs: Conforming to ANSI B16.14.

9. Thread Lubricant: Meet or exceed CGA ratings and compliant with Federal Specification TT-S-1732, manufactured compatible with fuel oil.

2.4 NATURAL GAS VALVES

A. 2-inches and Smaller: MSS SP-110 ball valves constructed in compliance with ASME B16.33. UL listed, FM approved, two-piece construction, threaded, bronze or brass body, full port, chrome plated brass ball, blowout-proof stem design, 125 PSI WOG working pressure.

B. 2-1/2-inches and Larger: 100 to 125 PSI rated, all bronze or iron body/bronze trimmed plug cock type, square head or tee/lever handle operation. CSA listed.

2.5 GAS EARTHQUAKE VALVE

A. Gas line valve providing automatic shutoff in case of earthquake. UL listed, CSA certified and FM approved. The valve or system to actuate shutoff means within 5 seconds when subjected to horizontal, sinusoidal oscillation having a peak acceleration of 0.3G (2.94 m/s2) and period of 0.4 seconds. Sensing means of valve or system not to actuate shutoff means when subjected for 5 seconds to horizontal, sinusoidal oscillations having:

1. A peak acceleration of 0.4G (3.94 m/s2) with a period of 0.1 second,

2. A peak acceleration of 0.08G (0.078 m/s2) with a period of 0.4 second, and

3. A peak acceleration of 0.08G (0.078 m/s2) with a period of 1.0 second.

B. Valve requires manual reset. Provide with needed spare parts to allow resetting after having been tripped. Valve to be same size as line size installed.

2.6 NATURAL GAS PRESSURE REGULATORS

A. Natural Gas: Diaphragm and spring actuated type, with ventless or vented relief feature. Construction, pressure range and venting features suitable for intended service. Regulator to meet code and serving utility requirements. Pipe vented type to atmosphere in approved location.

2.7 FLEXIBLE PIPE CONNECTORS - GAS PIPING (CSA LISTED)

A. Inner Hose: Type 304 stainless steel.

B. Exterior Sleeve: Braided, Type 304 stainless steel.

C. Pressure Rating: 175 PSI at 70 degrees F up to 4-inch pipe.

D. Joint: Threaded carbon steel.

E. Maximum Offset: 3/4-inch on each side of installed center line.

F. Flexible Connectors: Flexible connectors used in LP and LPG piping systems compliant with following:

1. Install in accordance with manufacturer's instructions.

2. Flexible connectors and hose used as flexible connectors not exceed 3-feet in length where used with liquid or vapor piping on portable or stationary tanks.

3. Hose permitted to be used if flexibility is required for liquid or vapor transfer.

PART 3 - EXECUTION

3.1 GENERAL INSTALLATION REQUIREMENTS

A. Inspection: Examine areas and conditions under which fuel systems materials and products are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected.

B. Identification: Install mechanical identification in accordance with Section 22 05 53, Identification for Plumbing Piping and Equipment.

C. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.

D. Remove scale and dirt on inside and outside before assembly.

E. Prepare piping connections to equipment with flanges or unions.

F. Keep open ends of pipe free from scale and dirt. Whenever work is suspended during construction protect open ends with temporary plugs or caps.

G. Install piping systems in accordance with manufacturer's instructions.

H. Route piping in orderly manner, plumb and parallel to building structure, and maintain gradient.

I. Install piping to conserve building space and avoid interference with use of space.

J. Sleeve pipe passing through partitions, walls, and floors.

K. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.

L. Provide piping mains, branches and runouts installed to allow for free expansion and contraction without developing leaks or undue stressing of pipe. Provide stresses within allowable limits of ANSI B31.1 for pressure piping.

M. Equipment Connections: Connect gas piping to each gas-fired equipment item, with drip leg and shutoff gas cock. Comply with equipment manufacturer's instructions. Flexible connections where required per ASCE 7-10 or shown on Drawings.

N. Piping Tests: Test natural gas piping in accordance with applicable mechanical code requirements, ANSI B31.2, and local utility requirements at a minimum of 100 psig for 24 hours.

3.2 FUEL PIPE AND PIPE FITTINGS - GENERAL

A. Black Steel: See 3.01 General Installation Requirements above and install per local code pressure test system to 100 psig for 24 hours.

B. Fuel Piping Installation:

1. General: Install pipe, tube and fittings in accordance with recognized industry practices which will achieve permanently leakproof piping systems, capable of performing each indicated service without piping failure. Install each route with a minimum of joints and couplings, but with adequate and accessible unions or flanges for disassembly, maintenance, and replacement of valves and equipment. Reduce sizes by use of reducing fittings. Align piping accurately at connections, within 1/16-inch misalignment tolerance. Comply with ANSI B31.9 Code for Pressure Piping. Provide shutoff valves, pressure regulators and unions at connections to gas-fired equipment. Provide dirt legs at low points.

2. Installed piping not to interfere with maintenance of equipment, opening of doors or other moving parts nor be directly above or near any portion of electrical equipment.

3. Support piping such that connected equipment does not bear weight of piping.

4. Adequately support vertical lines at their bases or by suitable hanger placed in horizontal line near riser or, preferably, by base fitting set on a pedestal.

5. Piping Through Roof: Coordinate roof penetrations prior to installation of piping. Coordinate location with roof structure and roof mounted equipment.

6. Ream steel pipes after cutting to full bore. Remove foreign matter from inside of pipe before installing. Keep installed piping free from dirt and scale and protect open ends from foreign matter. Use temporary plugs or other approved methods for opening and closure.

7. Remake or replace defective, leaking, or otherwise unsatisfactory joints or material. Peening, caulking, or doping of piping is not permitted.

8. Threading: Thread steel pipe in accordance with ANSI B21.1 with standard right hand threads. Cut threads full and clean using sharp dies. Ream threaded ends to remove burrs and restore full inside diameter. Apply pipe joint compound, or proper pipe joint tape where recommended by pipe/fitting manufacturer on male threads at each joint and tighten joint to leave not more than three threads exposed.

9. Sealants: Use sealants on metal fuel piping threads which are chemically resistant to fuel. Use sealants sparingly and apply only to male threads of metal joints.

10. Maintain electrically continuous piping system; provide grounding jumper where required to maintain continuity. Provide grounding connection; install per requirements of Division 26, Electrical.

11. Install dirt legs in gas piping where indicated and where required by code or regulation. Do not rest dirt leg on surface of roof, floor or deck.

12. Support gas piping above roof on preformed pipe stands. Guide pipes with clamp one size larger than pipe. Provide supports at intervals per code manufacturer, and details and at each change in direction. Wood blocks are not approved supports.

13. Gas Regulator Vent Piping: Provide Schedule 40, A53 black steel pipe and threaded black malleable threaded fittings for vent piping. Paint piping exposed to weather with primer and one coat of Safety Yellow Rustoleum.

14. Piping: Paint piping exposed to weather with primer and one coat of Safety Yellow Rustoleum.

3.3 STEEL PIPE AND FITTINGS, ABOVE GRADE INSTALLATION

A. See 3.01 General Installation Requirements above and install per current version of manufacturer's installation guidelines. Test system in accordance with requirements of local code and ANSI LC-1.

3.4 NATURAL GAS VALVE INSTALLATION

A. Prepare valves for shipping as follows:

1. Protect internal parts against rust and corrosion.

2. Protect threads, flange faces and weld ends.

3. Set ball valves open to minimize exposure of functional surfaces.

B. Use the following precautions during storage:

1. Maintain valve end protection.

2. Store valves indoors and maintain at higher than ambient dew-point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.

C. Do not attempt to repair defective valves; replace with new valves.

D. Gas Cocks: Provide at connection to gas train for each gas-fired equipment item, and on risers and branches where indicated.

E. Locate gas valves where easily accessible and protected from possible damage.

3.5 GAS EARTHQUAKE VALVE INSTALLATION

A. Install in strict accordance with manufacturer's written instructions and approved submittals.

B. Install earthquake valves per manufacturer's installation requirements. In a multi-building campus setting, provide a gas earthquake valve at each building gas point of entry whether shown on drawings or not.

C. Gas Cocks: Provide at connection to gas train for each gas-fired equipment item, and on risers and branches where indicated.

D. Locate gas valves where easily accessible and protected from possible damage.

3.6 NATURAL GAS PRESSURE REGULATORS INSTALLATION

A. Install in strict accordance with manufacturer's written instructions and approved submittals.

B. Vent regulators to outdoors as required.

C. Pressure Regulating Valves: Install as required at gas-fired appliances; comply with utility/code requirements. Pipe atmospheric vent to outdoors, full size outlet with 90 degree elbow downturn. Install gas shutoff valve upstream of each pressure regulating valve. Install in accordance with manufacturer's instructions to prevent freezing.

3.7 FLEXIBLE PIPE CONNECTORS - GAS PIPING (CSA LISTED) INSTALLATION

A. Install in strict accordance with manufacturer's written instructions and approved submittals.

END OF SECTION

SECTION 23 21 13 - HVAC PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Work Included:

1. Equipment Drains and Overflows
2. Unions
3. Refrigerant Piping

1.2 RELATED SECTIONS

A. Contents of Division 23, HVAC and Division 01, General Requirements apply to this Section.

1.3 REFERENCES AND STANDARDS

A. References and Standards as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.

1.4 SUBMITTALS

A. Submittals as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.

B. In addition, provide:

1. Welding Certificates: Copies of certificates for welding procedures and personnel.
2. Field Test Reports: Written reports of tests specified in Part 3 of this Section. Include the following:
    a. Test procedures used.
    b. Test results that comply with requirements.
    c. Failed test results and corrective action taken to achieve requirements.
3. Water Analysis: Submit a copy of the water analysis to illustrate water quality available at project site.
4. Buried piping manufacturer to submit thrust block (chilled water) and anchor plate (heating hot water) layout and details including anchorage and seismic calculations.

1.5 QUALITY ASSURANCE

A. Quality assurance as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.

B. In addition, meet the following:

1. Installer Qualifications: Company specializing in performing work of the type specified in this Section, with documented experience.

2. Welder Qualifications: Certify in accordance with ASME (BPV IX).

3. ASME Compliance: Comply with ASME B31.9 "Building Services Piping" for materials, products, and installation. Provide safety valves and pressure vessels with the appropriate ASME label. Fabricate and stamp air separators and expansion tanks to comply with the ASME Boiler and Pressure Vessel Code, Section VIII, Division 01.

4. Refrigerant Piping:

a. Welding: Qualify procedures and personnel according to ASME Boiler and Pressure Vessel Code: Section IX "Welding and Brazing Qualifications."

b. ASHRAE Standard: Comply with ASHRAE 15, "Safety Code for Mechanical Refrigeration."

c. ASME Standard: Comply with ASME B31.5, "Refrigeration Piping."

d. UL Standard: Provide products complying with UL 207, "Refrigerant-Containing Components and Accessories, Nonelectrical" or UL 429 "Electrically Operated Valves."

1.6 WARRANTY

A. Warranty of materials and workmanship as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements, General Requirements.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. As specified in Articles below.

2.2 EQUIPMENT DRAINS AND OVERFLOWS

A. Copper Tube: ASTM B 88 (ASTM B 88M), Type L (B), drawn.

1. Fittings: ASME B16.18, cast brass, or ASME B16.22 solder wrought copper.
2. Joints: Solder, lead free, ASTM B 32, HB alloy (95-5 tin-antimony), or tin and silver.

2.3 UNIONS

A. Unions for Pipe 2-inches and Under:

1. Ferrous Piping: 150 PSIG malleable iron, threaded, ASME B16.39.
2. Copper Pipe: Bronze, soldered joints, ASME B16.22.

B. Dielectric Connections: Provide dielectric waterway or brass nipple fitting with threaded ends. Dielectric unions are not allowed.

2.4 REFRIGERANT PIPING

A. Piping:

1. Copper Tube: ASTM B 280, Type ACR, drawn-temper tube, clean, dry and capped.
    a. Fittings: ASME B16.22 wrought copper.
    b. Joints: Braze, AWS A5.8 BCuP silver/phosphorus/copper alloy (15 percent Silver).
2. Copper Tube to 5/8-inch OD: ASTM B280. Tube ACR, annealed-temper copper tube, clean, dry and capped.
    a. Fittings: ASME B16.26 cast copper.
    b. Joints: Flared.

PART 3 - EXECUTION

3.1 GENERAL INSTALLATION REQUIREMENTS

A. Install per manufacturer's written instructions and requirements.

B. Preparation:

1. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.
2. Remove scale and dirt on inside and outside before assembly.
3. Prepare piping connections to equipment with flanges or unions.

4. Keep open ends of pipe free from scale and dirt. Protect open ends with temporary plugs or caps.

C. Pipe Painting Requirements:

1. Paint all ferrous metal pipe including flanges. Do not paint flange bolts, washers and nuts. At flexible coupling the only the flanges are to be painted. All rubber portions are to remain unpainted.

2. Paint exterior uninsulated steel piping with exterior latex, semi-gloss (AE), Master Painters Institute MPI 11, suitable for metallic surfaces B, Haze Gray color.

3. Use ready-mixed (including colors) paint. Prime paint with pigment and vehicle, compatible with substrate and finish coats specified. Volatile Organic Compounds (VOC) content of paint materials shall not exceed 50g/l for exterior latex paints and primers. Lead-based paint is not permitted.

4. Do not apply coating when air or substrate conditions are:

   a. Less than 5 degrees F above dew point.

   b. Below 50 degrees F or over 95 degrees F, unless specifically pre-approved by the product manufacturer.

5. Do no exterior painting when it is windy and dusty. Do not paint in direct sunlight or on surfaces that the sun will soon warm.

6. Apply only on clean, dry and frost-free surface. Remove all materials the will affect the ability of the paint to adhere to the pipe including painted pipe identification labels.

7. Remove oil, grease, soil, drawing and cutting compounds, flux and other detrimental foreign. Remove loose mill scale, rust, and paint, by hand or power tool cleaning. All surfaces are to be dry at the time paint is applied.

8. Apply paint in two coats; prime, and finish. Apply each coat evenly and cover substrate completely. Allow not less than 48 hours between application of succeeding coats, except as allowed by manufacturer's printed instructions.

9. Finish surfaces to show solid even color, free from runs, lumps, brushmarks, laps, holidays, or other defects. Apply by brush, roller or spray.

3.2 REFRIGERANT PIPING INSTALLATION

A. Install systems in accordance with ASHRAE Standard 15.

B. Group piping whenever practical at common elevations and locations. Slope piping one percent in direction of oil return.

C. Arrange piping to return oil to compressor. Provide traps and loops in piping, and provide double risers as required. Slope horizontal piping 0.40 percent in direction of flow.

D. Flood piping system with nitrogen when brazing.

E. Follow ASHRAE Standard 15 procedures for charging and purging of systems and for disposal of refrigerant.

F. Provide replaceable cartridge filter-driers, with isolation valves and valved bypass.

G. Locate expansion valve sensing bulb immediately downstream of evaporator on suction line.

H. Fully charge completed system with refrigerant after testing.

I. Field Quality Control:

1. Test refrigeration system in accordance with ASME B31.5.
2. Pressure test system with dry nitrogen to 200 PSI. Perform final tests at 27-inches vacuum and 200 PSI using electronic leak detector. Test to no leakage.

END OF SECTION

SECTION 23 31 00 - HVAC DUCTS AND CASINGS

PART 1 - GENERAL

1.1 SUMMARY

A. Work Included:

1. Ductwork, Joints and Fittings
2. Laundry Clothes Dryer Vent
3. Insulated Flexible Duct
4. Drain Pans
5. Ductwork Joint Sealers and Sealants

1.2 RELATED SECTIONS

A. Contents of Division 23, HVAC and Division 01, General Requirements apply to this Section.

B. In addition, reference the following:

1. Section 23 05 29, Hangers and Supports for HVAC Piping, Ductwork and Equipment.
2. Section 23 05 93, Testing, Adjusting, and Balancing for HVAC.

1.3 REFERENCES AND STANDARDS

A. References and Standards as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.

1.4 SUBMITTALS

A. Submittals as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.

B. In addition, provide:

1. Welding Certificates
2. Field Quality Control Reports

1.5 QUALITY ASSURANCE

A. Quality assurance as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.

B. In addition, meet the following:

1. NFPA Compliance:

a. NFPA 90A Installation of Air Conditioning and Ventilating Systems.

b. NFPA 90B, Installation of Warm Air Heating and Air Conditioning Systems.

2. Comply with SMACNA's HVAC Duct Construction Standards - Metal and Flexible for acceptable materials, material thicknesses, and duct construction methods, unless otherwise indicated. Provide sheet metal materials free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

1.6 WARRANTY

A. Warranty of materials and workmanship as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.

1.7 SYSTEM DESCRIPTION

A. Duct system design, as indicated, has been used to select size and type of air-moving and distribution equipment and other air system components. Duct design is generally diagrammatic and is not meant to be scaled. Major changes to layout or configuration of duct system must be specifically approved in writing by Architect. Accompany requests for layout modifications with calculations showing that proposed layout will provide original design results without increasing system total pressure.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Ductwork, Joints, and Fittings:

1. Ductmate

2. Lindab Inc

3. Nexus Inc

4. SEMCO

5. United McGill Corporation

6. Ward Industries

B. Insulated Flexible Duct:

1. ATCO

2. Flexmaster

3. J.P. Lamborn Co.

4. Hart and Cooley

C. Ductwork Joint Sealers and Sealants

1. Ductmate

2. Durodyne

3. Hardcast

4. United McGill Corporation

5. Vulkem

6. Foster

7. Childer

2.2 DUCTWORK, JOINTS AND FITTINGS

A. Materials:

1. Galvanized Steel Ducts: Hot-dipped galvanized steel sheet, lock-forming quality, ASTM A 653/A 653M FS Type B, with G90/Z275 coating. Ducts to have mill phosphatized finish for surfaces exposed to view.

2. Aluminum Ducts: ASTM B 209 (ASTM B 209M); aluminum sheet, alloy 3003-H14. Aluminum Connectors and Bar Stock: Alloy 6061-T651 or of equivalent strength with mill finish for concealed ducts and standard, 1-side bright finish for exposed ducts with liquid-tight joints when containing condensate vapor or liquids in suspension.

3. Stainless Steel: Fabricated in accordance with ASTM A167 and A480 with liquid-tight joints when containing condensate vapor or liquids in suspension.

B. Fabricate ducts, elbows, transitions, offsets, branch connections, and other construction according to SMACNA's HVAC Duct Construction Standards - Metal and Flexible and complying with requirements for metal thickness, reinforcing types and intervals, tie-rod applications, and joint types and intervals.

1. Lengths: Fabricate rectangular ducts in lengths appropriate to reinforcement and rigidity class required for pressure class.

2. Deflection: Duct systems not-to-exceed deflection limits according to SMACNA's HVAC Duct Construction Standards - Metal and Flexible.

3. Transverse Joints: Prefabricated slide-on joints and components constructed using manufacturer's guidelines for material thickness, reinforcement size and spacing, and joint reinforcement.

C. Formed-On Flanges: construct according to SMACNA's HVAC Duct Construction Standards - Metal and Flexible, Figure 1-4, using corner, bolt, cleat, and gasket details.

1. Duct Size: Maximum 30-inches wide and up to 2-inch wg pressure class.

2. Longitudinal Seams: Pittsburgh lock sealed with noncuring polymer sealant.

3. Cross Breaking or Cross Beading: Cross break or cross bead duct sides 19-inches and larger and 0.0359-inch thick or less, with more than 10 SF of nonbraced panel area unless ducts are lined.

D. Round, Spiral Lock-Seam Ducts: Fabricate supply ducts of material specified in this Section according to SMACNA's HVAC Duct Construction Standards - Metal and Flexible.

1. Ducts up to 20-inches in Diameter: Interior, center-beaded slip coupling, sealed before and after fastening, attached with sheet metal screws.

2. Ducts 21- to 72-inches in Diameter: Three-piece, gasketed, flanged joint consisting of two internal flanges with sealant and one external closure band with gasket.

3. Ducts Larger than 72-inches in Diameter: Companion angle flanged joints per SMACNA HVAC Duct Construction Standards-Metal and Flexible, Figure 3-2.

4. Round Ducts: Prefabricated connection system consisting of double-lipped, EPDM rubber gasket. Manufacture ducts according to connection system manufacturer's tolerances.

E. 90-Degree Tees and laterals and Conical Tees: Fabricate to comply with SMACNA's HVAC Duct Construction Standards-Metal and Flexible, with metal thicknesses specified for longitudinal-seam straight ducts.

F. Diverging-Flow Fittings: Fabricate with reduced entrance to branch taps and with no excess material projecting from fitting onto branch tap entrance.

G. Fabricate elbows using die-formed, gored, pleated, or mitered construction. Bend radius of die-formed, gored, and pleated elbows to be 1.5 times duct diameter. Unless elbow construction type is indicated, fabricate elbows as follows:

1. Mitered-Elbow Radius and Number of Pieces: Welded construction complying with SMACNA's HVAC Duct Construction Standards-Metal and flexible, unless otherwise indicated.

2. Round Mitered Elbows: Welded construction with the following metal thickness for pressure classes from minus 2- to plus 2-inch wg (minus 500 to plus 500 Pa):

    a. Ducts 3- to 36-inches in Diameter: 0.034-inch .

    b. Ducts 37- to 50-inches in Diameter: 0.040-inch.

    c. Ducts 52- to 60-inches in Diameter5: 0.052-inch.

    d. Ducts 62- to 84-inches in diameter: 0.064-inch.

3. Round Mitered Elbows: Welded construction with the following metal thickness for pressure classes from 2- to 10-inch wg:

    a. Ducts 3- to 26-inches in Diameter: 0.034-inch.

    b. Ducts 27- to 50-inches in Diameter: 0.040-inch.

    c. Ducts 52- to 60-inches in Diameter: 0.052-inch.

    d. Ducts 62- to 84-inches in Diameter: 0.064-inch.

4. 90-Degree, Two-Piece, Mitered Elbows: Use only for supply systems or for material-handling Class A or B exhaust systems and only where space restrictions do not permit using radius elbows. Fabricate with single-thickness turning vanes.

5. Round Elbows

    a. 8-inches and Less in Diameter: Fabricate die-formed elbows for 45 and 90-degree elbows and pleated elbows for 30, 45, 60 and 90 degrees only.

Fabricate nonstandard bend-angle configurations or non-standard diameter elbows with gored construction.

b. 9 through 14-inches in Diameter: Fabricate gored or pleated elbows for 30, 45, 60 and 90 degrees unless space restrictions require mitered elbows. Fabricate nonstandard bend-angle configurations or nonstandard diameter elbows with gored construction.

c. Larger than 14-inches in Diameter and All Flat-Oval Elbows: Fabricate gored elbows unless space restrictions require mitered elbows.

6. Die-Formed Elbows for Sizes through 8-inches in Diameter and Pressures 0.040-inch thick with two-piece welded construction.

7. Round Gored-Elbow Metal Thickness: Same as non-elbow fittings specified above.

8. Pleated Elbows for Sizes through 14-inches in Diameter and Pressures through 10-inch wg (2500 Pa): 0.022-inch.

9. Not acceptable:

   a. Corrugated or flexible metal duct.

   b. Adjustable elbows.

2.3 LAUNDRY CLOTHES DRYER VENT

A. Aluminum sheet metal, minimum 24 gauge. Substantially airtight duct except for openings required for operation and maintenance. Duct to have smooth interior surface. Do not assemble with sheet metal screens or other devices that extend into the airstream.

2.4 INSULATED FLEXIBLE DUCT

A. Construction: Standard factory fabricated product. Inner wall: Impervious vinyl or chlorinated polyethylene, permanently bonded to a vinyl or zinc-coated spring steel helix.

B. Insulation: Fiberglass blanket insulation covered by an outer wall of vinyl or fiberglass-reinforced metalized vapor barrier.

C. Listing: UL 181 listed Class 1 flexible air duct material. Overall thermal transmission: No more than 0.25 BTU/in or hr/sq. degrees F at 75 degrees F differential, per ASTM C335.

D. Vapor transmission value no more than 0.10 perm, per ASTM E96

E. Pressure Rating: 4-inch wg positive pressure and 1-inch wg negative pressure.

F. Performance Air Friction Correction Factor: 1.3 maximum at 95 percent extension. Working air velocity: Minimum 2000 FPM.

G. Flame Spread Rating: No more than 25.

H. Smoke Development Rating: No more than 50 as tested per ASTM E84.

I. Insertion Loss: Minimum attenuation of 29 DB for 10-foot straight length at 8-inch diameter at 500 Hz.

2.5 DRAIN PANS

A. Primary Drain Pans: Stainless Steel, Fabricated in accordance with ASTM A167 and A480.

B. Secondary Drain Pans: Galvanized Steel: Hot-dipped galvanized steel sheet, ASTM A 653/A 653M FS Type B, with G90/Z275 coating.

2.6 DUCTWORK JOINT SEALERS AND SEALANTS

A. Joint Sealers and Sealants: Non-hardening, water resistant, mildew and mold resistant.

B. Low Emitting Materials Requirement: Adhesives, sealants and sealant primers must comply with South Coast Air Quality Management District (SCAQMD) Rule #1168.

C. Type: Heavy mastic or liquid used alone or with tape, suitable for joint configuration and compatible with substrates, and recommended by manufacturer for pressure and leakage class of ducts.

D. Surface Burning Characteristics: Flame spread of zero, smoke developed of zero, when tested in accordance with ASTM E 84.

E. Water Based Sealant for Brush-On Application: Flexible, adhesive sealant, resistant to UV light, UL-181A, and UL-181-B listed, complying with NFPA requirements for Class 1 ducts. Min. 69 percent solids, nonflammable. Hardcast Versa-Grip 181; Childers CP-146; Foster 32-19 for SMACNA 1/2, 1, 2, 3, 4, 6, and 10-inch WG duct classes, and SMACNA Seal Class A, B, or C.

F. Flanged Joint Mastic: One-part, acid-curing, silicone, elastomeric joint sealant complying with ASTM C920, Type S, Grade NS, Class 25, Use O.

G. Flange Gaskets: Butyl rubber or EPDM polymer with polyisobutylene plasticizer.

H. Polyurethane Sealant: General-purpose, exterior use, non-brittle sealant for gunned application. Vulkem 616 or equal.

PART 3 - EXECUTION

3.1 GENERAL INSTALLATION REQUIREMENTS

A. General: Use the following pressure seal, and leakage class(es) in design of ductwork specified in this section unless otherwise noted on Drawings.

SYSTEM	PRESSURE CLASS (Inches of Water)	SEAL CLASS	LEAKAGE CLASS ROUND DUCTS	LEAKAGE CLASS RECTANGULAR DUCTS
Low pressure	+ 1-inch	A	3	6
Return main (>24-inch)	0.5-inch more negative than return/exhaust fan pressure or -2-inch pressure class, whichever is more negative.	A	3	6
Return branch (<24-inch)	0.5-inch more negative than return/exhaust fan pressure or -2-inch pressure class, whichever is more negative.	A	3	6
General exhaust	0.5-inch more negative than return/exhaust fan pressure or -2-inch pressure class, whichever is more negative.	A	3	6
Lab medium pressure exhaust (lab valve/terminal unit to fan)	-6-inch	A	3	6
Lab low pressure exhaust (upstream of lab valve/terminal unit)	-1-inch	A	3	6

SYSTEM	PRESSURE CLASS (Inches of Water)	SEAL CLASS	LEAKAGE CLASS ROUND DUCTS	LEAKAGE CLASS RECTANGULAR DUCTS
Hazardous exhaust	-6-inch	A	3	6

B. Ductwork Installation:

1. General: Install entire duct system in accordance with drawings, Specifications, and latest issues of local Mechanical Code, NFPA 90A, and SMACNA Duct Construction Manual. At Contractor's option, rectangular ductwork may be resized to maintain an equivalent air velocity and friction rate, while maintaining a maximum aspect ratio of 3. Remove markings and tagging from ductwork exterior surface in mechanical rooms and other locations where ductwork is exposed.

2. The duct layout shown on the Contract Drawings is diagrammatic in nature. Coordinate the ductwork routing and layout, and make alterations to the ductwork routing and layout to eliminate physical interferences. Where deviations in the ductwork routing as shown in the Contract Drawings are required, alterations may be made so as not to compromise the air flow, pressure drop, and sound characteristics of the duct fitting or duct run as shown on the Contract Drawings. In the event Architect determines that the installed ductwork is inconsistent with the above mentioned criteria, remove and replace at no additional cost to the Owner.

3. Install ducts with fewest possible joints.

4. Install fabricated fittings for changes in directions, size, shape, and for connections.

5. Install couplings tight to duct wall surface with a minimum of projections into duct. Secure couplings with sheet metal screws. Install screws at intervals of 12-inches, with a minimum of 3 screws in each coupling.

6. Install ducts, unless otherwise indicated, vertically and horizontally and parallel and perpendicular to building lines; avoid diagonal runs.

7. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.

8. Install ducts with a clearance of 1-inch, plus allowance for insulation thickness. Allow for easy removal of ceiling tile.

9. Conceal ducts from view in finished spaces. Do not encase horizontal runs in solid partitions unless specifically indicated.

10. Coordinate layout with suspended ceiling, air duct accessories, lighting layouts, and similar finish work.

11. Electrical and IT Equipment Spaces: route ducts to avoid passing through transformer vaults, electrical equipment spaces, IDF/MPOE rooms, and enclosures.

12. Non-Fire-Rated Partition Penetrations: Where ducts pass through interior partitions and exterior walls and are exposed to view, conceal spaces between construction openings and ducts or duct insulation with sheet metal flanges of same metal thickness as ducts. Overlap openings on 4 sides by at least 1-1/2-inches.

13. Fire- and Smoke-Rated Partition Penetrations: Where ducts pass through interior partitions and exterior walls, install appropriately rated fire, smoke or combination fire and smoke dampers as governed by Building Code and AHJ, including sleeves, and firestopping sealant.

14. Install ducts with hangers and braces designed to withstand, without damage to equipment, seismic force required by applicable building codes. Reference SMACNA's Seismic Restraint Manual: Guidelines for Mechanical Systems, Mason Seismic Restraint and Support Systems.

15. Protect duct interiors from the elements and foreign materials until building is enclosed. Follow SMACNA's Duct Cleanliness for New Construction Advanced Level.

16. Paint interiors of metal ducts, that do not have duct liner, for 24-inches upstream of registers and grilles. Apply one coat of flat, black, latex finish coat over a compatible duct material.

17. Install ductwork in the location and manner shown and detailed. Review deviations required by job conditions with Architect prior to any fabrication. Provide fittings for construction per SMACNA.

18. Install flexible ductwork to limit sag between support hangers to 1/2-inch per foot of spacing support.

C. Flanged Take-Offs:

1. Install at branch takeoffs to outlets using round or flex duct.

2. Flanged take-offs secured with minimum 8-inch screw spacing (three screws minimum).

3. Provide ductwork taps and branches off of main ducts at 45 degrees whether shown on Drawings or not (drawings are diagrammatic).

D. Cleaning:

1. Clean duct systems with high power vacuum machines. Protect equipment that could be harmed by excessive dirt with filters, or bypass during cleaning. Provide adequate access into ductwork for cleaning purposes.

2. Grille and Exposed Duct Cleaning:

a. After completion of ductwork installation, operate each fan system (excluding exhaust fans) for a minimum of 30 minutes prior to installation of ceiling grilles and diffusers. After grilles and diffusers are installed, clean out accumulation of particles from grilles and diffusers prior to acceptance.

b. Clean exterior surface of ducts exposed to public view of chalk, pencil and pen marks, labels, sizing tags, dirt, dust, etc., so that upon completion of installation, ducts are left in clean and unblemished manufactured conditions.

c. Exposed duct and grilles to remain free of dust entrained streaks due to leakage at joints and grille connections during warranty period. Clean leaks, seal and refinish to match existing if visible streaks develop.

3.2 DUCTWORK, JOINTS AND FITTINGS INSTALLATION

A. Duct Materials - Applied Locations:

1. General: Use the following materials in design of ductwork specified in this Section unless otherwise noted on the Drawings.

Location or Application	Material
Supply, Return, Transfer, and Exhaust - Low Pressure	Single Wall, Galvanized Steel
Supply, Return, Exhaust serving area of high corrosion or moisture	Single Wall, Aluminum or Type 304 Stainless Steel
Fume Hood Exhaust	Single Wall, Type 316 Stainless Steel

B. Ductwork Installation:

1. Fabricate radius elbows with centerline radius not less than 1-1/2 duct diameters.

2. Do not install duct size transition pitch angles which exceed 30 degrees for reductions in duct size in the direction of airflow, and 15 degrees for expansions in duct size in the direction of airflow.

3. Install fixed turning vanes in square throat rectangular elbows and in tees.

4. Fabricate duct turns with the inside (smallest) radius at least equal to the duct width (supply ducts) and 1.5 times radius (return and exhaust ducts). Where necessary, square elbows may be used, with maximum available inside radius and with fixed turning vanes. In healthcare settings such as hospitals and medical office buildings, square elbows and turning vanes allowed on supply ductwork only.

3.3 LAUNDRY CLOTHES DRYER VENT

A. Install vent in accordance with manufacturer's instructions and recommendations.

3.4 INSULATED FLEXIBLE DUCT INSTALLATION

A. Provide sheet metal plenum or rigid elbow and connect to diffusers and grilles with ductwork connections. Refer to Drawings for more information. Provide straight section of flexible duct with minimum length of 2-feet and maximum length of 5-feet and connect to sheet metal plenums and rigid elbows connected to diffusers and grilles, unless noted otherwise.

1. Provide round neck grilles/diffusers or square-to-round transitions. Flexible duct connections directly to diffuser and grilles is not allowed.

2. Flexible duct allowed in concealed spaces above lay-in ceilings only.

3.5 DRAIN PANS INSTALLATION

A. Install where shown on Drawings. Drain provided by Division 22, Plumbing. Provide drain (sized per code) connection from each drain pan and pipe to nearest floor drain through trap and 10-inch air gap. Drain pans over 6-feet in length require drain connections from both ends. Pitch drain pans in direction of air flow and to drain. Support secondary drain pan independently from equipment.

3.6 DUCTWORK JOINT SEALERS AND SEALANTS INSTALLATION

A. Joints and Seam Joint Sealing:

1. Seal duct seams and joints according to SMACNA's HVAC Duct Construction Standards - Metal and Flexible, for duct pressure class indicated.

2. Seal transverse joints, longitudinal seams and duct wall penetrations including screw, fastener, pipe, rod, and wire.

3. Seal ducts before external insulation is applied.

4. Fasteners such as sheet-metal screws, machine screws or rivets to be cadmium plated.

5. Rectangular Ductwork: Where intermediate joint reinforcement is required for duct of negative pressure class, pre-drill stiffening flange and provide fastener maximum 8-inches on center. Where retaining flanges are welded to duct wall, paint welds with zinc coating.

6. Single Wall Round Ductwork: Joint to incorporate beaded slip collar with minimum #8 sheet metal screws 8-inches on center. Seal ductwork as specified in this Section.

7. Seal joints and seams. Apply sealant to make end connectors before insertion, and afterward to cover entire joint and sheet metal screws.

8. Double Wall Round Ductwork: Joint to incorporate beaded slip collar or flanged connection, with minimum #8 sheet metal screws 8-inches on center. Seal ductwork as specified in this Section.

9. Duct sizes indicated are inside clear dimensions. For lined ducts, maintain sizes inside lining.

10. Provide openings in ductwork where required to accommodate thermometers and control devices. Provide pitot tube openings where required for testing of systems, complete with metal can with spring device or screw to ensure against air leakage. Where openings are provided in insulated ductwork, install insulation material inside a metal ring.

11. Locate ducts with sufficient space around equipment to allow normal operating and maintenance activities as well as Code required clearances.

END OF SECTION

SECTION 23 33 00 - AIR DUCT ACCESSORIES

PART 1 - GENERAL

1.1 SUMMARY

A. Work Included:

1. Sheet Metal Materials
2. Backdraft Dampers
3. Dampers
4. Concealed Damper Hardware
5. Access Doors
6. Duct Test Holes
7. Control Dampers
8. Flexible Connectors

1.2 RELATED SECTIONS

A. Contents of Division 23, HVAC and Division 01, General Requirements apply to this Section.

1.3 REFERENCES AND STANDARDS

A. References and Standards as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.

1.4 SUBMITTALS

A. Submittals as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.

B. In addition, provide:

1. Manufacturer's catalog data and fabrication/installation drawings for each factory fabricated duct accessory. Include leakage, pressure drop and maximum back pressure data.
2. Shop Drawings: Indicate air duct accessories.

3. Manufacturer's installation instructions: Provide instructions for each factory fabricated duct accessory.

4. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.

   a. See Division 01, General Requirements, Product Requirements for additional provisions.

   b. Extra Fusible Links: One of each type and size.

1.5 QUALITY ASSURANCE

A. Quality assurance as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.

B. In addition, meet the following:

1. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this Section, with minimum five years of documented experience.

2. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

3. AMCA 500 - Test Methods for Louvers, Dampers and Shutters.

4. AMCA 511 - Certified Ratings Program for Air Control Devices.

5. AMCA 611, latest edition - Certified Ratings Program - Product Rating Manual for Airflow Measurement Stations.

6. AMCA 610, latest edition - Laboratory Methods of Testing Airflow Measurement Stations for Performance Rating.

7. NFPA 90A - Installation of Air Conditioning and Ventilating Systems.

1.6 WARRANTY

A. Warranty of materials and workmanship as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Backdraft Dampers:

1. Air Balance
2. Cesco
3. Greenheck
4. Nailor
5. Ruskin

B. Dampers:

1. Air Balance
2. Cesco
3. Greenheck
4. Nailor
5. Ruskin

C. Concealed Damper Hardware, Cable System:

1. Young Regulator Company

D. Access Doors:

1. Ductmate
2. Cesco
3. Ruskin
4. Nailor
5. Outdoor Installation: Karp MX insulated exterior access door.

E. Duct Test Holes:

1. Ventlok

F. Control Dampers:

1. Ruskin
2. Greenheck

3. Cesco

4. Air Balance

5. Nailor

G. Flexible Connectors:

1. Duro Dyne Corp.

2. Ventfabrics Inc.

3. Ductmate Industries

4. Hardcast

2.2 SHEET METAL MATERIALS

A. Comply with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods, unless otherwise indicated.

B. Galvanized Sheet Steel: Lock-forming quality; complying with ASTM A 653/A 653M. Galvanizing: 1-1/4 ounces per square foot total both sides; ducts to have mill-phosphatized finish for surfaces exposed to view.

C. Stainless Steel: ASTM A 480/A 480M.

D. Aluminum Sheets: ASTM B 209 (ASTM B 209M), alloy 3003, temper H14; with mill finish for concealed ducts and standard, 1-side bright finish for exposed ducts.

E. Extruded Aluminum: ASTM B 221 (ASTM B 221M), alloy 6063, temper T6.

F. Reinforcement Shapes and Plates: Galvanized-steel reinforcement where installed on galvanized sheet metal ducts; compatible materials for aluminum and stainless-steel ducts.

G. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for lengths 36-inches or less; 3/8-inch minimum diameter for lengths longer than 36-inches.

2.3 BACKDRAFT DAMPERS

A. Basis-of-Design: Ruskin CB D6.

B. Description: Multiple-blade gravity balanced with center pivoted blades with sealed edges, assembled in rattle free manner with 90-degree stop, adjustment device to permit setting for varying differential static pressure.

C. Frame: 0.125-inch thick 6063-T5 extruded aluminum channel with galvanized steel braces at mitered corners. Provide mounting flange.

D. Blades: Single piece, overlap frame, parallel action, horizontal orientation, minimum 0.07-inch 6063-T5 extruded aluminum material, maximum 6-inch width.

E. Bearings: Corrosion-resistant synthetic, formed as single piece with axles.

F. Blade Seals: Extruded vinyl, mechanically attached to blade edge.

G. Blade Axles: Corrosion-resistant, synthetic formed as single piece with bearings, locked to blade.

H. Tie Bars and Brackets: Galvanized steel.

I. Return Spring: Adjustable tension.

J. Damper Capacity:

1. Closed Position: Maximum back pressure of 16-inches water gauge.

2. Open Position: Maximum air velocity of 2,500-feet per minute.

K. Counterbalances: Adjustable zinc plated steel weights mechanically attached to blade. Must be capable of operating over wide range of pressures.

L. Finish: Mill aluminum.

M. Temperature Rating: -40 degrees F to 200 degrees F.

N. Operation of Blade:

1. Start to Open: 0.01-inch wg

2. Fully Open: 0.05-inch.

O. Pressure Drop: Maximum 0.15-inch wg at 1,500-feet per minute through 24-inch by 24-inch damper.

P. Factory Sleeve: Minimum 20 gauge thickness, 12-inches in length.

Q. Screen: At outdoor intake or discharge. 1/4-inch aluminum.

2.4 DAMPERS

A. Basis-of-Design: Ruskin MD 35.

B. General Description: Factory fabricated, with required hardware and accessories. Stiffen damper blades for stability. Include locking device to hold single-blade dampers in a fixed position without vibration. Close duct penetrations for damper components to seal duct consistent with pressure class.

1. Pressure Classes of 3-Inch wg (750 Pa) or Higher: End bearings or other seals for ducts with axles full length of damper blades and bearings at both ends of operating shaft.

C. Rectangular Volume Dampers: Multiple- or single-blade, parallel- or opposed-blade design with linkage concealed in frame and suitable for horizontal or vertical applications.

1. Steel Frames: Hat-shaped, galvanized sheet steel channels, minimum 16 gauge thick, with mitered and welded corners; frames with flanges where indicated for attaching to walls and flangeless frames where indicated for installing in ducts.

    a. Roll-Formed Steel Blades: 16 gauge thick, galvanized sheet steel.

    b. Aluminum Frames: Hat-shaped, 10 gauge thick, aluminum sheet channels; frames with flanges where indicated for attaching to walls; and flangeless frames where indicated for installing in ducts.

    c. Roll-Formed Aluminum Blades: 10 gauge thick aluminum sheet.

    d. Extruded-Aluminum Blades: 16 gauge thick extruded aluminum.

    e. Blade Axles: Minimum 1/2-inch diameter, plated steel, hex shaped, mechanically attached to blade.

    f. Bearings: Molded synthetic sleeve, turning in extruded hole in frame.

    g. Tie Bars and Brackets: Galvanized steel.

    h. Mill galvanized.

    i. Capacity:

        1) Closed Position: Maximum pressure of 3-inches wg.

        2) Open Position: Maximum air velocity of 1,500-feet per minute across 24-inch by 24-inch damper.

D. Round Volume Dampers: Single-blade suitable for horizontal or vertical applications.

1. Steel Frames: Galvanized, roll formed, minimum of 20 gauge thick with beads at each end.

2. Blades: Minimum 20 gauge thick, galvanized sheet steel, round, single-piece.

3. Aluminum Frames: Minimum 10 gauge thick aluminum sheet.

4. Aluminum Blades: Minimum 10 gauge thick aluminum sheet.

5. Extruded-Aluminum Blades: Minimum 16 gauge thick extruded aluminum.

6. Blade Axles: Minimum 3/8-inch square, plated steel, mechanically attached to blade.

7. Bearings: Molded synthetic sleeve, turning in hole in frame.

8. Finish: Mill galvanized.

9. Capacity:

    a. Closed Position: Maximum pressure of 3-inches wg

    b. Open Position: Maximum air velocity of 1,500-feet per minute.

10. Leakage: Maximum 40 cfm at 1-inch wg for 20-inches diameter damper.

11. Pressure Drop: Maximum 0.02-inch wg at 1,500-feet per minute through 20-inch diameter dampers.

E. Jackshaft: 1-inch diameter, galvanized-steel pipe rotating within pipe-bearing assembly mounted on supports at each mullion and at each end of multiple-damper assemblies.

1. Length and Number of Mountings: Appropriate to connect linkage of each damper in multiple-damper assembly.

2. Damper Hardware: Zinc-plated, die-cast core with dial and handle made of 3/32-inch thick zinc-plated steel, and a 3/4-inch hexagon locking nut. Include center hole to suit damper operating-rod size. Include 2-inch elevated platform for insulated duct mounting.

2.5 CONCEALED DAMPER HARDWARE

A. Concealed Damper Hardware: For dampers above non-removable ceilings (gyp, plaster, decorative, etc.) where access panels have not been shown on Architectural drawings or in locations where dampers are more than 2-feet above the ceiling, provide:

1. Concealed Damper Regulator: Young Regulator Company Model 315 or approved equivalent.

2. Cable System: Young Regulator Company or approved equivalent.

3. Controller: Young Regulator Company 270-275 or approved equivalent.

4. Control wrenches, wire stops, casing nuts, and stainless steel wire.

5. Paint cover plate to match ceiling color or as directed by Architect.

2.6 ACCESS DOORS

A. Duct Pressure Class 2-inch WC and Greater: Sandwich-type design with threaded locking bolt assembly. Closed cell neoprene gasket permanently bonded to inside panel. Zinc-coated steel wing nuts or polypropylene molded knobs with threaded metal inserts - zinc coated bolts sealed to inner panel.

B. Duct Pressure Class 1-1/2-inch WC and Less: Galvanized steel assembly incorporating frame, door, hinges, and latch(es). Frame tabbed for attachment to duct panel. Double wall door panel with 1-inch insulation. Open cell neoprene gasket attached to frame. Cam latches for tight closure.

C. Plenum Doors: Extruded aluminum frames with extruded santoprene seals. Double-wall 20 gauge galvanized steel door panel with fiberglass insulation.

D. Size: Maximum size available to fit rectangular duct panel dimension or round duct diameter. Plenum doors minimum 2-feet wide by 4-feet high.

E. For outdoor installation, only provide waterproof access doors installed vertically.

2.7 DUCT TEST HOLES

A. Temporary Test Holes: Cast iron or cast aluminum to suit duct material, including screw cap and gasket. Size to allow insertion of pitot tube and other testing instruments and of length to suit duct insulation thickness.

2.8 CONTROL DAMPERS

A. Basis-of-Design:

1. Ruskin Model CDR25, low leakage, for use in low pressure round ductwork up to 24-inch diameter.

2. Ruskin Model CDO25, low leakage, for use in low pressure oval ductwork.

3. Ruskin Model CD60, ultra low leakage, for rectangular ducts or round ductwork larger than 24-inch diameter. Provide duct transition between round and rectangular connections.

B. Fabrication:

1. Frame: 16 gauge roll formed, galvanized steel hat-shaped channel, reinforced at corners. Structurally equivalent to 13 gauge U-channel.

2. Blades (Low Leakage Dampers):

    a. Style: Single skin with 3 longitudinal grooves.

    b. Action: Opposed blade for modulating applications, parallel blade for two position application.

    c. Orientation: Horizontal or vertical with thrust washers.

    d. Material: Minimum 16 gauge equivalent thickness, galvanized steel.

    e. Width: Nominal 6-inches.

3. Blades (Ultra Low Leakage Dampers):

    a. Style: Airfoil-shaped, single-piece.

    b. Action: Opposed blade for modulating applications, parallel blade for two position applications.

    c. Orientation: Horizontal or vertical with thrust washers.

    d. Material: Minimum 14 gauge equivalent thickness, galvanized steel.

    e. Width: Nominal 6-inches.

4. Bearings: Molded synthetic sleeve, turning in extruded hole in frame.

5. Seals:

    a. Blade: Inflatable PVC coated fiberglass material and galvanized steel. Mechanically attached to blade edge.

    b. Jamb: Flexible metal compression type.

6. Linkage: Concealed in frame.

7. Axles: Minimum 1/2-inch diameter plated steel, hex-shaped, mechanically attached to blade.

8. Mounting: Vertical or horizontal.

9. Finish: Mill galvanized for installation in galvanized sheet metal and Type 304 stainless steel for installation in stainless steel ductwork.

C. Performance Data (Low Leakage Dampers):

1. Capacity: Demonstrate capacity of damper to withstand HVAC system operating conditions.

   a. Closed Position: Maximum pressure of 5-inches wg at a 12-inch blade length.

   b. Open Position: Maximum air velocity of 2,000-feet per minute.

2. Leakage: Maximum 3.7 cubic-feet per minute per square foot at 1-inch wg for sizes 36-inches wide and above.

3. Pressure Drop: Maximum 0.07-inch wg at 1,500-feet per minute across 24-inch by 24-inch damper.

D. Performance Data (Ultra Low Leakage Dampers):

1. Leakage: Damper to have a maximum leakage of 3 cfm per square foot at 1-inch wg and be AMCA licensed as Class 1A.

2. Differential Pressure:

   a. Damper to have a maximum differential pressure rating of 13-inch wg for a 12-inch blade.

3. Velocity: Damper to have a maximum velocity rating of 6,000-feet per minute.

4. Temperature: Damper rated for -72 degrees F to 275 degrees F.

5. Pressure Drop: Maximum 0.1-inch wg at 2,000-feet per minute across 24-inch by 24-inch damper.

E. Actuator: Provide actuator. See Specification Section 23 09 00, Instrumentation and Control for HVAC.

F. Factory flange frame

G. Factory Sleeve: Minimum 20 gauge thickness.

H. Duct Transition Connection: Per Drawings.

I. Factory Tests: Factory cycle damper assembly to assure proper operation.

2.9 FLEXIBLE CONNECTORS

A. General Description: Flame-retardant or noncombustible fabrics, coatings, and adhesives complying with UL 181, Class 1.

B. Metal-Edged Connectors: Factory fabricated with a fabric strip 4-inches wide attached to two strips of 2-3/4-inch wide, 0.028-inch thick, galvanized sheet steel or 0.032-inch thick aluminum sheets. Select metal compatible with ducts.

C. Provide a spring and bracket assembly to reinforce the fabric with sufficient tension to prevent connector collapse under negative or positive pressure. Number and positioning of spring-link fixture to be determined by the manufacturer to maintain straight axis and without kinks between two sections of duct, or between duct and the moving element. Hardcast Spring-Link SL-200, or equal.

D. Indoor System, Flexible Connector Fabric (FC-I): Glass fabric double coated with neoprene.

1. Minimum Weight: 26 ounces per square yard.
2. Tensile Strength: 300 pounds of force per inch in the warp and 225 pounds of force per inch in the filling.
3. Service Temperature: -40 degrees F to 200 degrees F.

E. Outdoor System, Flexible Connector Fabric (FC-O): Glass fabric double coated with weatherproof, synthetic rubber resistant to UV rays and ozone.

1. Minimum Weight: 30 ounces per square yard.
2. Tensile Strength: 475 pounds of force per inch in the warp and 375 pounds of force per inch in the filling.
3. Service Temperature: -40 degrees F to 200 degrees F.

F. High-Corrosive-Environment System, Flexible Connectors (FC-HC): Glass fabric with chemical-resistant coating.

1. Minimum Weight: 14 ounces per square yard.
2. Tensile Strength: 450 pounds of force per inch in the warp and 340 pounds of force per inch in the filling.

3. Service Temperature: -67 degrees F to 500 degrees F.

PART 3 - EXECUTION

3.1 DUCT ACCESSORIES GENERAL INSTALLATION

A. Inspect areas to receive air duct accessories. Notify Engineer of conditions that would adversely affect the installation of the dampers. Do not proceed until conditions are corrected.

B. Install duct accessories according to applicable details in SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for metal ducts.

C. Provide duct accessories of materials suited to duct materials; use galvanized-steel accessories in galvanized-steel, stainless-steel accessories in stainless-steel ducts, and aluminum accessories in aluminum ducts.

D. Do not compress or stretch damper frames into duct or opening.

E. Handle dampers using sleeve or frame. Do not lift dampers using blades, actuators, or jack shafts.

F. Adjust duct accessories for proper settings.

3.2 SHEET METAL MATERIALS INSTALLATION

A. Install bracing for multiple sections to support assembly weights and hold against system pressure. Install bracing as needed.

3.3 BACKDRAFT DAMPERS INSTALLATION

A. Install backdraft dampers on exhaust fans or exhaust ducts nearest to outside and where indicated. Provide at outside air intakes where motorized dampers are not shown on drawings.

3.4 DAMPERS INSTALLATION

A. Where installing volume dampers in ducts with liner, avoid damage to and erosion of duct liner.

B. Provide balancing dampers at points on supply, return, and exhaust systems where branches lead from larger ducts for air balancing. Install at a minimum of two duct widths from each branch takeoff. Provide balancing dampers for all air inlets and outlets.

C. Install dampers square and free from racking with blade running horizontally.

3.5 CONCEALED DAMPER HARDWARE INSTALLATION

A. Coordinate location in Reflected Ceiling Plan and color of concealed damper hardware with Architect prior to installation.

3.6 ACCESS DOORS INSTALLATION

A. Install duct access doors to allow for inspecting, adjusting, and maintaining accessories and terminal units as follows:

1. On both sides of duct coils.
2. Downstream from volume dampers, turning vanes and equipment.
3. Adjacent to fire or smoke dampers, providing access to reset or reinstall fusible links.
4. To interior of ducts for cleaning; before and after each change in direction, at maximum 50-foot (15-m) spacing.
5. Install the following sizes for duct-mounting, rectangular access doors:
    a. One-Hand or Inspection Access: 8-inches by 5-inches.
    b. Two-Hand Access: 12-inches by 6-inches.
    c. Head and Hand Access: 18-inches by 10-inches.
    d. Head and Shoulders Access: 21-inches by 14-inches.
    e. Body Access: 25-inches by 14-inches.
    f. Body Plus Ladder Access: 25-inches by 17-inches.
6. Install the following sizes for duct-mounting, round access doors:
    a. One-Hand or Inspection Access: 8-inches in diameter.
    b. Two-Hand Access: 10-inches in diameter.
    c. Head and Hand Access: 12-inches in diameter.
    d. Head and Shoulders Access: 18-inches in diameter.
    e. Body Access: 24-inches in diameter.
7. Label access doors.

3.7 DUCT TEST HOLES INSTALLATION

A. Provide test holes at fan inlets and outlets where indicated and where required for air testing and balancing.

3.8 CONTROL DAMPERS INSTALLATION

A. Handle dampers using sleeve or frame. Do not lift dampers using blades, actuators or jack shafts.

B. Install control dampers in accordance with manufacturer's written instructions.

3.9 FLEXIBLE CONNECTORS INSTALLATION

A. Install flexible connectors immediately adjacent to equipment in ducts associated with fans and motorized equipment supported by vibration isolators. Provide sheet metal weather cover over flexible connections located outdoors. Attach sheet metal to either equipment side or ductwork side, but not both.

B. Per NFPA, do not use flexible connectors on grease exhaust fans.

C. Securely attach spring-lock brackets to the metal strips of the connector collar using No. 8 sheet metal screws.

D. For fans developing static pressures of 5-inch wg and higher, cover flexible connectors with loaded vinyl sheet held in place with metal straps.

E. Adjust the following types in the following locations:

1. FC-I: Indoors.
2. FC-O: Outdoors.
3. FC-HC: High corrosive systems inclusive of all laboratory exhaust systems.

END OF SECTION

SECTION 23 34 00 - HVAC FANS

PART 1 - GENERAL

1.1 SUMMARY

A. Work Included:

1. Centrifugal Fans
2. Roof Exhaust Fans
3. Ceiling Exhaust Fans
4. In-Line Centrifugal Fans

1.2 RELATED SECTIONS

A. Contents of Division 23, HVAC and Division 01, General Requirements apply to this Section.

1.3 REFERENCES AND STANDARDS

A. References and Standards as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.

1.4 SUBMITTALS

A. Submittals as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.

B. In addition, provide:

1. Certified fan performance curves with system operating conditions indicated.
2. Certified fan sound-power ratings.
3. Motor ratings and electrical characteristics, plus motor and electrical accessories.
4. Material gauges and finishes, including color charts.
5. Dampers, including housings, linkages, and operators.

1.5 QUALITY ASSURANCE

A. Quality assurance as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.

B. In addition, meet the following:

1. Motors: Premium efficiency per Section 23 05 13, Common Motor Requirements for HVAC Equipment. Electrically Commutated Motors (ECM) where scheduled on Drawings.

2. Sound power levels as scheduled on Drawings. If not scheduled, within 5 percent of Basis of Design at design flow.

3. Project Altitude: Base air ratings on sea-level conditions for project sites below 2,000 feet in elevation. Base air ratings on actual site elevations for project sites above 2,000 feet in elevation.

4. Operating Limits: Classify according to AMCA 99.

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

6. AMCA Compliance: Products are to comply with performance requirements and are to be licensed to use the AMCA-Certified Ratings Seal.

7. NEMA Compliance: Motors and electrical accessories are to comply with NEMA standards.

8. UL Standard: HVAC Fans are to comply with UL 705. Fans used in grease exhaust applications are to be UL 762 listed for grease exhaust.

1.6 WARRANTY

A. Warranty of materials and workmanship as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver fans as factory-assembled unit, to the extent allowable by shipping limitations, with protective crating and covering.

B. Disassemble and reassemble units, as required for moving to final location, according to manufacturer's written instructions.

C. Lift and support units with manufacturer's designated lifting or supporting points.

1.8 COORDINATION

A. Coordinate size and location of structural-steel support members.

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

C. Coordinate installation of roof curbs, equipment supports, and roof penetrations.

1.9 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents. Belts: One set for each belt-driven unit.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Centrifugal Fans:

1. Greenheck
2. Cook
3. Twin City

B. Roof Exhaust Fans:

1. Greenheck
2. Cook
3. Twin City

C. Ceiling Exhaust Fans:

1. Greenheck
2. Cook
3. Broan
4. Twin City

D. In-Line Centrifugal Fans:

1. Greenheck
2. Cook
3. Twin City

2.2 CENTRIFUGAL FANS

A. Description: Centrifugal or utility type centrifugal fans, as indicated, standard factory finish, AMCA rated, single width, single inlet, double width, double inlet, forward curved, backward inclined, or airfoil blades as scheduled.

B. Wheel and Inlet:

1. Backward Inclined: Steel or aluminum construction with smooth curved inlet flange, heavy back plate, backwardly curved blades welded or riveted to flange and back plate; cast iron or cast steel hub riveted to back plate and keyed to shaft with set screws.

2. Airfoil Wheel: Steel construction with smooth curved inlet flange, heavy back plate die formed hollow airfoil shaped blades continuously welded at tip flange, and back plate; cast iron or cast steel hub riveted to back plate and keyed to shaft with set screws.

3. Statically and dynamically balance wheel within its own bearings with maximum balance quality grade at bearings of G16 (0.20 in/sec peak velocity, filter-in as measured at fan RPM) for 5 hp and below and G6.3 (0.15 in/sec peak velocity, filter-in as measured at fan RPM) for 7.5 hp and above per ANSI S2.19. AMCA 210 rated.

C. Housing:

1. Heavy gauge steel, spot welded for AMCA 99 Class I and II fans, and continuously welded for Class III, adequately braced, designed to minimize turbulence with spun inlet bell and shaped cut.

2. Finish: Factory finish to manufacturer's standard (Permatector) or Factory finish to manufacturer's standard with Hi-Pro polyester finish exceeding 1,000 hours of salt spray under ASTM B117 test method. Prime coating of aluminum parts is not allowed.

3. Removable angles and bolts for attaching flexible connections and discharge dampers on fan outlet.

4. Housing Discharge Arrangement: Adjustable to eight standard positions.

D. Bearings and Drives

1. Bearings: Heavy duty pillow block type, self-greasing ball bearings, with ABMA 9 L-10 life at 100,000 hours.

2. Shafts: Hot rolled steel, ground and polished, with keyway, protectively coated with lubricating oil, and shaft guard. Provide anti-corrosive coating.

3. Drive: Cast iron or steel sheaves, dynamically balanced, keyed. Variable and adjustable pitch sheaves for motors 5 hp and under, selected so required rpm is obtained with sheaves set at mid-position fixed sheave for 7.5 hp and over, matched belts, and drive rated as recommended by manufacturer or minimum 1.5 times nameplate rating of motor.

4. Belts: Oil resistant, nonsparking, and nonstatic; matched sets for multiple belt drives.

5. Belt Guard: Fabricate to SMACNA Duct Construction Standards - Metal and Flexible; 0.106-inch thick, 3/4-inch diamond mesh wire screen welded to steel angle frame or equivalent, prime coated. Secure to fan or fan supports without short circuiting vibration isolation, with provision for adjustment of belt tension, lubrication, and use of tachometer with guard in place.

E. Motor: Integrally mounted, 1800 RPM maximum, with pre-lubricated sealed ball bearings. ODP for motors located indoors and TEFC for motors exposed to moisture.

F. Accessories:

1. Inlet/Outlet Screens: Galvanized steel welded grid, removable, at unit outlet for outdoor installation, and unit inlet for unducted conditions.

2. Access Doors: Shaped to conform to scroll, with quick opening latch type handles and gaskets.

3. Scroll Drain: 1/2-inch steel pipe coupling welded to low point of fan scroll for outdoor installation.

4. AMCA 99 Type B spark proof construction where scheduled.

5. Protective coating on fan wheel and interior of fan housing where scheduled. Apply coating before balancing fans and repair any breaks in coating which occur during balancing. One 6-mil coat of white plastic #7122 and one 6-mil coat of black plastic #7122.

6. Vibration isolation as specified. Reference Section 23 05 48, Vibration and Seismic Controls for HVAC Piping and Equipment.

2.3 ROOF EXHAUST FANS

A. Description: Belt-driven or direct-driven centrifugal fans consisting of housing, wheel, fan shaft, bearings, motor and disconnect switch, drive assembly, curb base, and accessories.

B. Wheel:

1. Single width, single inlet, backward inclined/airfoil blades
2. Aluminum hub and wheel with steel inlet bell.
3. Statically and dynamically balanced with its own bearings.

C. Housing to match scheduled Basis of Design:

1. One piece heavy gauge spun aluminum dome, hinged for service.

D. Bearings and Drives:

1. Bearings: Heavy duty pillow block type, self greasing ball bearings with ABMA 9 L-10 life at 100,000 hours.
2. Shafts: Hot rolled steel, ground and polished, with keyway, protectively coated with lubricating oil.

E. Pulleys: Cast-iron, adjustable-pitch motor pulley.

F. Fan and motor isolated from exhaust airstream.

G. Curb: Prefabricated insulated roof curb, galvanized steel, mitered ad welded corners; 1-1/2-inch thick, rigid, fiberglass insulation adhered to inside walls; and 1-1/2-inch wood nailer, hinged with curb seal. Provide curb for flat, pitched or ridged roof as indicated.

H. Motor: Integrally mounted, 1800 RPM maximum, with pre-lubricated sealed ball bearings. ODP for motors located indoors and TEFC for motors exposed to moisture.

1. Inverter duty motor for use with variable frequency drive where indicated on Fan Schedule on Drawings.
2. Electrically Commutated Motor (ECM) where indicated on Fan Schedule on Drawings.

I. Accessories:

1. Inlet/Outlet Screens: Galvanized steel welded grid, removable.

2. Backdraft Damper: Parallel blade heavy duty steel or aluminum, where scheduled, damper assembly with blades constructed of two plates formed around and welded to shaft, channel frame, sealed ball bearings, with blades linked out of air stream to single control lever. Motorized where indicated and gravity actuated with counterweight, where motorized is not indicated.

3. AMCA 99 Type B spark proof construction where scheduled.

4. Protective coating on fan wheel and interior of fan housing where scheduled. Apply coating before balancing fans and repair any breaks in coating which occur during balancing. One 6-mil coat of white plastic #7122 and one 6-mil coat of black plastic #7122.

5. Variable-Speed Controller: Where scheduled on Drawings, provide solid-state control to reduce speed from 100 percent to less than 50 percent.

6. Disconnect Switch: Where not shown on Division 26, Electrical Drawings, provide nonfusible type, with thermal-overload protection mounted inside fan housing factory wired through an internal aluminum conduit.

7. Vibration Isolation: Wheel and motor mounted on integral double deflection neoprene isolators.

2.4 CEILING EXHAUST FANS

A. Description: Centrifugal fan, direct drive, cabinet and exhaust grille. AMCA rated. Sound level as scheduled. Fan shrouds, motor, and fan wheel are to be removable for service.

B. Wheel: Double width, double inlet, forward curved blades:

C. Housing: Acoustically insulated steel casing, factory standard finish, bottom access through grille, ducted outlet, egg crate inlet grille. Provide stainless steel grille where scheduled.

D. Drives: Direct drive.

E. Back draft damper.

F. Accessories:

1. Disconnect plug.

2. Flat roof cap.

3. Hooded wall cap.

4. Pitched roof cap.

5. Elbow discharge with grille.

6. Louvered wall discharge with bird screen.

G. Motor: Integrally mounted with pre-lubricated sealed ball bearings.

1. Variable-Speed Controller: Where scheduled on Drawings, provide solid-state control to reduce speed from 100 percent to less than 50 percent.

2. Disconnect Switch: Where not shown on Division 26, Electrical Drawings, provide nonfusible type, with thermal-overload protection mounted inside fan housing factory wired through an internal aluminum conduit.

3. Manual Starter Switch: Single-pole rocker switch assembly with cover and pilot light.

4. Time-Delay Switch: Assembly with single-pole rocker switch, timer, and cover plate.

5. Motion Sensor: Motion detector with adjustable shutoff timer.

6. Electrically Commutated Motor (ECM) where indicated on Fan Schedule on Drawings.

H. Filter: Washable aluminum to fit between fan and grille.

I. Isolation: Rubber-in-shear vibration isolators.

2.5 IN-LINE CENTRIFUGAL FANS

A. Description: In-line, belt-driven, centrifugal fans consisting of housing, wheel, outlet guide vanes, fan shaft, bearings, motor and disconnect switch, drive assembly, mounting brackets, and accessories.

B. Wheel: Cast aluminum backward inclined with inlet cone statically and dynamically balanced within its own bearings.

C. Housing:

1. Heavy gauge steel or aluminum, suitable for Fan Class, flat roof cap, hooded wall cap, pitched roof cap, elbow discharge with grille, and louvered wall discharge housing, factory standard finish.

2. Removable panels for access to all interior components.

3. Horizontal or vertical configuration, as indicated.

4. Inlet and discharge duct collars.

5. 1-inch thick, 1.5 pounds per cubic foot density fiberglass liner.

6. Aluminum straightening vanes.

7. Support bracket adaptable to floor, sidewall, or ceiling mounting.

D. Bearings and Drives:

1. Bearings: Heavy duty pillow block type, self greasing ball bearings with ABMA 9 life at 50,000 hours.

2. Shafts: Hot rolled steel, ground and polished, with keyway, protectively coated with lubricating oil.

3. Drive: Cast iron or steel sheaves, dynamically balanced, keyed. Variable and adjustable pitch sheaves for motors 5 hp and under, selected so required rpm is obtained with sheaves set at mid-position. Fixed sheave for 7.5 hp and over, matched belts, and drive rated as recommended by manufacturer or minimum 1.5 times nameplate rating of motor. Motor mounted on adjustable base, with adjustable sheaves, enclosure around belts within fan housing, and lubricating tubes from fan bearings extended to outside of fan housing.

   a. Inverter duty motor for use with variable frequency drive where indicated on Fan Schedule on Drawings.

4. Drive: Direct drive matched to fan loads with speed controller. Motor encased in housing outside of airstream, factory wired to disconnect switch located on outside of fan housing.

   a. Electrically Commutated Motor (ECM) where indicated on Fan Schedule on Drawings.

E. Accessories:

1. Belt guard.

2. Motor cover for outdoor applications.

3. Inlet and outlet guard.

4. AMCA 99 Type B spark proof construction where scheduled.

5. Variable-Speed Controller: Provide solid-state control to reduce speed from 100 percent to less than 50 percent for motors 1/2 HP or smaller.

6. Discharge Dampers: Parallel blade for mixing or open/close applications and opposed blade for modulating . Heavy duty steel or aluminum, where scheduled. Damper assembly with blades constructed of two plates formed around and welded to shaft, channel frame, sealed ball bearings, with blades linked out of air stream to single control lever. Motorized where indicated and gravity actuated with counterweight, where motorized is not indicated.

F. Inlet/Outlet Screens: Galvanized steel welded grid, removable.

G. Vibration Isolation: Wheel and motor mounted on integral double deflection neoprene isolators.

H. Vibration isolation as scheduled and specified. Reference Section 23 05 48, Vibration and Seismic Controls for HVAC Piping and Equipment.

1. Motor: Integrally mounted, 1800 RPM maximum, with pre-lubricated sealed ball bearings. ODP for motors located indoors and TEFC for motors exposed to moisture.

PART 3 - EXECUTION

3.1 GENERAL INSTALLATION REQUIREMENTS

A. Install in accordance with manufacturer's instructions.

B. Install power ventilators level and plumb.

C. Fans used for exhaust of kitchen grease hoods are to be UL 762 listed for grease exhaust. Provide fans with grease terminator. Pipe from grease terminator to Code approved location.

D. Fans used for exhaust of moist air are to be constructed of aluminum construction and be warranted for their application in moist conditions.

E. Fans used in welding, chemical, and/or fume exhaust applications are to be of spark-proof construction and are to be protected with coatings as required to protect parts in the air stream from the chemicals and materials the fan will be exposed to.

F. Install floor-mounting units on concrete bases.

G. Units using vibration isolation devices are scheduled on Drawings.

H. Support suspended units from structure threaded steel rods and vibration isolation device scheduled on Drawings.

I. In seismic zones, restrain support units.

J. Install units with clearances for service and maintenance.

K. Provide fixed sheaves required for final air balance.

L. Provide safety screen where inlet or outlet is exposed.

M. Pipe scroll drains to nearest floor drain.

N. Provide backdraft dampers on discharge of exhaust fans and as indicated on Drawings.

O. Duct installation and connection requirements are specified in other Division 23, HVAC Sections. Drawings indicate general arrangement of ducts and duct accessories. Make final duct connections with flexible connectors per Section 23 33 00, Air Duct Accessories.

P. Install ducts adjacent to power ventilators to allow service and maintenance.

Q. Ground equipment.

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

S. Equipment Startup Checks:

1. Verify that shipping, blocking, and bracing are removed.
2. Verify that unit is secure on mountings and supporting devices and that connections to ducts and electrical components are complete. Verify that proper thermal-overload protection is installed in motors, starters, and disconnect switches.
3. Verify that cleaning and adjusting are complete.
4. Disconnect fan drive from motor, verify proper motor rotation direction, and verify fan wheel free rotation and smooth bearing operation. Reconnect fan drive system, align and adjust belts, and install belt guards.
5. Verify lubrication from bearings and other moving parts.

6. Verify that manual and automatic volume control and fire and smoke dampers in connected ductwork systems are in fully open position.

7. Disable automatic temperature-control operators.

T. Starting Procedures:

1. Energize motor and adjust fan to indicated rpm.

2. Measure and record voltage and amperage.

U. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation. Remove malfunctioning units, replace with new units, and retest.

V. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

W. Shut unit down and reconnect automatic temperature-control operators.

X. Replace fan and motor pulleys as required to achieve design airflow.

Y. Provide totally enclosed fan cooled motors when motor is located outdoors, whether under a cover or not, or exposed to moisture. Provide protective covering for electronically commutated motors located in outdoor or wet/wash-down locations.

Z. Repair or replace malfunctioning units. Retest as specified above after repairs or replacements are made.

AA. Adjust damper linkages for proper damper operation.

AB. Adjust belt tension.

AC. Lubricate bearings.

AD. On completion of installation, internally clean fans according to manufacturer's written instructions. Remove foreign material and construction debris. Vacuum fan wheel and cabinet.

AE. After completing system installation, including outlet fitting and devices, inspect exposed finish. Remove burrs, dirt, and construction debris and repair damaged finishes.

AF. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain HVAC fans. Train Owner's maintenance personnel on procedures and schedules for starting and stopping, troubleshooting, servicing, and maintaining equipment and schedules.

3.2 ROOF EXHAUST FANS

A. Secure roof exhaust fans to roof curbs with cadmium-plated hardware.

3.3 CEILING EXHAUST FANS

A. Suspend units from structure; use steel wire or metal straps.

END OF SECTION

SECTION 23 37 00 - AIR OUTLETS AND INLETS

PART 1 - GENERAL

1.1 SUMMARY

A. Work Included:

1. Grilles, Registers, Diffusers

2. Louvers

1.2 RELATED SECTIONS

A. Contents of Division 23, HVAC and Division 01, General Requirements apply to this Section.

1.3 REFERENCES AND STANDARDS

A. References and Standards as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.

1.4 SUBMITTALS

A. Submittals as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.

B. In addition, provide:

1. Data Sheet: For each type of air outlet and inlet, and accessory furnished; indicate construction, finish, and mounting details.

2. Performance Data: Include throw and drop, static-pressure drop, and noise ratings for each type of air outlet and inlet.

3. Schedule of diffusers, registers, and grilles indicating drawing designation, room location, quantity, model number, size and accessories furnished.

1.5 QUALITY ASSURANCE

A. Quality assurance as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.

B. In addition, meet the following:

1. Air Distribution Diffuser, Register, and Grille Schedule lists Basis of Design, with any specialty accessories, construction, finish or other criteria noted on schedule. Submitted air distribution must match criteria of Basis of Design:

a. Construction materials and appearance.

b. Frame/installation method.

c. Isothermal throw plus or minus 5 percent at design flows shown on Drawings.

d. Noise Criteria: NC value plus or minus 1 at design flows shown on Drawings.

e. Accessories: Equal to Basis of Design.

1.6 WARRANTY

A. Warranty of materials and workmanship as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. General: Manufacturer's standard products of categories and types required for each application as referenced in other Division 23, HVAC sections, where more than a single type is specified for the application, provide single selection for each product category.

B. Grilles, Registers, Diffusers:

1. Carnes
2. Environmental Air Products
3. Krueger
4. Metalaire
5. Nailor
6. Price Co.
7. Titus
8. Tuttle & Bailey
9. Seiho
10. Or approved equivalent.

C. Louvers:

1. Ruskin Manufacturing
2. Pottorff
3. Carnes
4. Cesco
5. Greenheck
6. Or approved equivalent.

2.2 GRILLES, REGISTERS, DIFFUSERS

A. Diffuser, Register and Grille Schedule lists Basis of Design, with specialty accessories, construction, finish or other criteria noted on schedule. Submitted air distribution must match criteria of Basis of Design, including accessories and finish:

   1. Matching construction materials and appearance. Equal installation method/frame.
   2. Pressure drop equal to or less than Basis of Design at CFM on Drawings.
   3. Throw: Isothermal jet throw plus or minus 5 percent of Basis of Design at CFM listed on Drawings.
   4. Noise Criteria: Plus or minus 1 NC of Basis of Design at CFM listed on Drawings. If Basis of Design NC is below registered level, submitted must match. NC rating with 10 dB room factor or less.

B. Provide 1-, 2-, 3-, or 4-way deflection as indicated on Drawings.

C. Provide pattern controllers for linear supply air diffusers.

D. Register Dampers: Dampers utilized with grilles. Opposed blade dampers utilizing a side operated worm drive which provides external duct operation. Slot the end of the shaft to receive a screwdriver. Factory assembled side operator. Construct of the same material as the grille. Manufacturer same as grilles/diffuser.

E. Coordinate mounting frames with ceiling construction type. Verify per reflected ceiling plans.

2.3 LOUVERS

A. General: Frame and sill styles compatible with adjacent substrate, specifically manufactured to fit into construction openings with accurate fit and adequate support for weatherproof installation. Reference Drawings and Specifications for types of substrate which will contain each type of louver. Construct of aluminum extrusions, ASTM B221, Alloy 6063-T5. Weld units or use stainless steel fasteners. On inside face of exterior louvers, provide anodized aluminum wire bird screen mounted in removable extruded aluminum frames. AMCA licensed performance ratings.

B. Blades set 3 to 5-inches on center, 37.5 degree angle with rain hook on blade, minimum blade thickness 0.080-inch, drainable blade style. Minimum 57 percent free area for 48-by 48-inch unit. Maximum water penetration 0.01 ounce water psf free area at 1000 FPM. Maximum intake pressure drop of 0.10-inch wg at 750 FPM free velocity. Provide downspouts in jambs, designed to drain water from louver for minimum water cascade from blade to blade. Provide drain gutter in head frame and each blade.

C. Reference Drawings for free area required.

D. Provide access door in duct to clean birdscreen.

E. Finish: Factory Kynar 500 fluoropolymer spray finish; color to be selected by Architect. Conform to AAMA 605.2. Apply coating following cleaning, and pretreatment. Dry louvers before final finish application. 1.2 mils total dry film thickness when baked at 450 degrees F for ten minutes.

PART 3 - EXECUTION

3.1 GENERAL INSTALLATION

A. Install in accordance with manufacturer's instructions. Provide seismic supports, clips, and bracing per local code. Coordinate installation of framing. Provide complete coverage of rough openings by integral device flanges or auxiliary frames. Where above ceiling location is unconditioned space, caulk rough openings; repair and re-paint locations where dust entrainment streaks develop due to unsealed openings.

B. Damp locations, such as lockers, restrooms, showers, natatoriums, whirlpool/spas, to have aluminum construction even if scheduled otherwise; mounting hardware to be stainless steel.

C. Check location of outlets and inlets and make necessary adjustments in position to conform with architectural features, symmetry, and lighting arrangement.

D. Unless otherwise shown on drawings, for ceiling mounted air outlets with adjustable airflow pattern controllers mounted at a height of 12 feet or less, adjust the air outlets for horizontal air distribution, and adjust to vertical air distribution for ceiling height above 12 feet.

E. Exterior color of grilles per Architect. White finish if not otherwise scheduled or noted by Architect. Paint ductwork visible behind air outlets and inlets matte black.

F. Ceiling Membrane: Protect ceiling membrane per code. Fire caulk around openings. Provide listed radiation damper in rated roof/ceiling or floor/ceiling assemblies as required per code.

G. After installation of diffusers, registers, and grilles, inspect exposed finish. Clean exposed surfaces to remove burrs, dirt, and smudges. Replace diffusers, registers, and grilles that have damaged finishes.

3.2 GRILLES, REGISTERS AND DIFFUSERS INSTALLATION

A. Coordinate with Architectural Reflected Ceiling Plan(s). Reflected ceiling plans determine final locations.

B. Install diffusers to ductwork with air tight connection. 18-inch straight duct section or acoustic plenum at connection. Provide square to round adapters where required for connection to round ducts.

C. Provide integral balancing dampers for diffusers, and grilles and registers where duct manual balancing dampers are not shown or specified.

D. Linear Slot Diffusers:

1. Coordinate connection plenum dimensions with linear slot final dimensions to conform with manufacturer's recommendations, or as indicated. Total and active lengths as noted on drawings. Blank off unused sections. Coordinate frame type with Architect.

2. Paint surfaces visible behind air outlets and inlets, including blank-off sections, matte black unless otherwise called for on drawings.

END OF SECTION

SECTION 23 40 00 - HVAC AIR CLEANING DEVICES

PART 1 - GENERAL

1.1 SUMMARY

A. Work Included:

1. Disposable Panel Filters

1.2 RELATED SECTIONS

A. Contents of Division 23, HVAC and Division 01, General Requirements apply to this Section.

B. In addition, reference the following:

1. Division 01, General Requirements, Temporary Facilities and Controls: Filters for temporary heating and ventilating.
2. Division 26, Electrical, Equipment Wiring: Electrical characteristics and wiring connections.

1.3 REFERENCES AND STANDARDS

A. References and Standards as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.

B. In addition, meet the following:

1. ANSI/AHRI 850 I-P - Performance Rating of Commercial and Industrial Air Filter Equipment.
2. ASHRAE Std 52.1 - Gravimetric and Dust-Spot Procedures for Testing Air Cleaning Devices Used in General Ventilation for Removing Particulate Matter; American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc.
3. ASHRAE Std 52.2 - Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size; American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc.
4. Standard 52.2 - Method of testing general ventilation air-cleaning devices for removal efficiency by particle size.
5. UL 900 - Standard for Air Filter Units; Underwriters Laboratories Inc.

1.4 SUBMITTALS

A. Submittals as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.

B. In addition, provide:

1. Product Data: Provide data on filter media, filter performance data, filter assembly and filter frames, dimensions, motor locations and electrical characteristics and connection requirements.

2. Shop Drawings: Indicate filter assembly and filter frames, dimensions, motor locations, and electrical characteristics and connection requirements.

3. Manufacturer's Installation Instructions: Indicate assembly and change-out procedures.

4. Operation and Maintenance Data: Include instructions for operation, changing, and periodic cleaning.

5. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.

    a. See Division 01, General Requirements for additional provisions.

    b. Extra Filters: One set of each type and size.

1.5 QUALITY ASSURANCE

A. Quality assurance as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.

B. In addition, meet the following:

1. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

1.6 WARRANTY

A. Warranty of materials and workmanship as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.

1.7 PERFORMANCE REQUIREMENTS

A. Conform to ANSI/AHRI 850 I-P - Performance Rating of Commercial and Industrial Air Filter Equipment, Section 7.4.

1. Dust Spot Efficiency: Plus or minus 5 percent.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Filters:

1. American Filtration Inc.
2. AAF International/American Air Filter
3. Camfil Farr Company
4. Eco-Air Products
5. Filtration Group
6. Flanders Corporation
7. Or approved equivalent.

2.2 DISPOSABLE PANEL FILTERS

A. Media: UL 900 Class 2, fiber blanket, factory sprayed with flameproof, non-drip, non-volatile adhesive.

1. Nominal Size: 12 x 24-inches.
2. Thickness: 1-inch.

B. Performance Rating:

1. Face Velocity: 500 FPM.
2. Face Velocity: 350 FPM (2.54 m/sec).
3. Initial Resistance: 0.15-inch WG.
4. Initial Resistance: 0.23-inch WG (37 Pa).
5. Recommended Final Resistance: 0.50-inches WG.
6. MERV Rating: 8.

C. Casing: Cardboard frame.

D. Holding Frames: 20 gauge minimum galvanized steel frame with expanded metal grid on outlet side and steel rod grid on inlet side, hinged with pull and retaining handles.

PART 3 - EXECUTION

3.1 GENERAL INSTALLATION REQUIREMENTS

A. Install air cleaning devices in accordance with manufacturer's instructions.

B. Prevent passage of unfiltered air around filters with felt, rubber, or neoprene gaskets.

C. Furnish and install filter gauge static pressure tips upstream and downstream of filters. Mount filter gauges on outside of filter housing or filter plenum, in accessible position/location. Adjust and level.

D. Operation During Construction: If air handlers are operated during construction, provide treated 2-inch media construction filter in front of prefilters and replace periodically to prevent dirt carryover. Install clean prefilters prior to air balancing.

E. Do not operate fan system until filters (temporary or permanent) are in place. Replace temporary filters used during construction and testing, with clean set.

F. Provide filter gauges on filter banks, installed with separate static pressure tips upstream and downstream of filters.

END OF SECTION

SECTION 23 62 01 - VARIABLE REFRIGERANT FLOW_VOLUME (VRF_VRV) SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Work Included:

1. Outdoor Unit (Simultaneous Heating and Cooling)
2. Branch Selector Units for VRF Heat Recovery System (Daikin Applied System)
3. Branch Circuit (BC) Controllers (Mitsubishi Systems)
4. Heat Recovery Unit (LG System)
5. Indoor Unit - Wall Mounted
6. Indoor Unit - Ceiling Concealed Ducted (High Static)
7. Controls for VRV Systems

B. Variable capacity, heat pump air conditioning system.

C. System consists of an outdoor unit, branch circuit terminal or branch selector units, multiple indoor fan units and PID DDC (Direct Digital Controls). Each indoor unit or group of indoor units capable of operating in any mode independently of other indoor units or groups. System capable of changing mode (cooling to heating, heating to cooling) with no interruption to system operation. Each indoor unit or group of indoor units independently controlled. Sum of connected capacity of indoor air handlers range from 50 percent to 130 percent of outdoor rated capacity.

D. Variable capacity heat pump system (non-heat recovery) system consist of outdoor unit, multiple indoor units and PID DDC (Direct Digital Controls). Sum of connected capacity of indoor air handlers range from 50 percent to 130 percent of outdoor rated capacity. Heating mode or cooling mode/no simultaneous operation.

1.2 RELATED SECTIONS

A. Contents of Division 23, HVAC and Division 01, General Requirements apply to this Section.

B. In addition, reference the following:

1. Refer to Section 23 72 23, Packaged Air-to-Air Energy Recovery Units for VRF/VRV manufacturer's indoor energy recovery unit.

1.3 REFERENCES AND STANDARDS

A. References and Standards as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.

1.4 SUBMITTALS

A. Submittals as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.

1.5 QUALITY ASSURANCE

A. Quality assurance as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.

B. In addition, meet the following:

1. Facility manufacturing registered to ISO 9001 and ISO 14001.
2. Full charge of R-410A provided in condensing unit from factory.
3. Units to be listed by Electrical Laboratories (ETL) and bear the ETL label.
4. Wiring in accordance with the National Electric Code (NEC).
5. The system will bear the Energy Star label.
6. The installing contractor to receive instruction and training from the equipment manufacturer prior to installation. Instruction to cover manufacturer's recommended methods for piping, wiring, leak testing, etc. Documentation of the training is to be provided to the Architect for review.

1.6 WARRANTY

A. Warranty of materials and workmanship as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.

B. In addition, provide:

1. Five year warranty on compressor(s).

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Daikin (latest series).

B. Trane/Mitsubishi (latest series).

C. LG (latest series).

D. Approved Alternate Manufacturer: Drawings indicate Basis of Design manufacturer, alternate acceptable manufacturers listed may be provided, meeting capacities of Basis of Design system. Each alternate manufacturer has a specific refrigerant distribution system that is proprietary. Therefore, alternate proposed systems are to include the cost of refrigerant distribution modifications, equipment location modification, condensate and secondary condensate over flow modifications, electrical modifications, architectural modifications, structural modifications, maintenance and access modifications, and other modifications required to submit the manufacturer that is not the Basis of Design.

2.2 OUTDOOR UNIT (SIMULTANEOUS HEATING AND COOLING)

A. General:

1. Outdoor unit specifically for use with manufacturer VRF/VRV components. Multiple circuit boards that interface to controls system, to perform functions necessary for operation. Outdoor unit module factory assembled, piped and wired and run tested at factory.

2. Outdoor unit sound rating no higher than 60 dB(A) individually or 63 dB(A) twinned. Night mode sound rating no higher than 50 dB(A) individually or 53 dB(A) twinned.

3. Individually insulate refrigerant lines from outdoor unit to indoor units.

4. Accumulator with refrigerant level sensors and controls.

5. High pressure safety switch, over-current protection, crankcase heater and DC bus protection.

6. Heating mode operation down 0 degrees F ambient temperature or cooling mode down to 23 degrees F ambient temperature, without additional low ambient controls.

7. Unit not to cease operation in any mode based solely on outdoor ambient temperature.

8. High efficiency oil separator plus additional logic controls to maintain adequate oil volume in compressor.

9. The system will automatically restart operation after a power failure and will not cause any settings to be lost. System not to require re-programming in the event of power failure.

10. The outdoor unit to be modular in design and to allow for side-by-side installation following manufacturer's recommended clearances.

B. Unit Cabinet:

1. Casing(s) to be completely weatherproof and fabricated of galvanized steel, bonderized and finished. Withstand 960 hours per ASTM B117 criteria for seacoast protected models.

C. Fan:

1. Direct drive, variable speed propeller type fan. Factory set for operation under 0-inch WG external static pressure, but capable of normal operation under maximum of 0.24-inch WG external static pressure via dipswitch.

2. Inherent fan motor protection, permanently lubricated bearings, and variable speed.

3. Mounted for quiet operation.

4. Raised guard to prevent contact with moving parts.

5. Vertical discharge airflow.

D. Refrigerant:

1. R410A refrigerant.

E. Outdoor Coil:

1. Nonferrous construction with lanced or corrugated plate fins on copper tubing.

2. Factory applied corrosion resistant finish on fins.

3. Integral metal coil guard.

4. Refrigerant flow controlled by inverter driven compressor.

F. Compressor:

1. Inverter driven scroll hermetic compressor.

2. Factory mounted crankcase heater(s).

3. Inverter capacity modulation. Variable capacity with turndown of 14 percent of rated capacity, depending upon unit size.

4. Equipped with internal thermal overload.

5. The compressor(s) to be mounted on rubber-in-shear isolators to avoid the transmission of vibration.

G. Electrical:

1. The power supply to the outdoor unit to be as scheduled on the drawings.

2. The control voltage between the indoor and outdoor unit to be 16 VDC or 24 VDC non-shielded 2 conductor cable.

3. The control wiring to be a two-wire multiplex transmission system, connecting multiple indoor units to one outdoor unit with a single 2-cable wire.

2.3 BRANCH SELECTOR UNITS FOR VRF HEAT RECOVERY SYSTEM (DAIKIN SYSTEM)

A. General:

1. The sum of connected capacity of indoor air handlers to range from 50 percent to 130 percent of rated capacity.

2. The branch selector units must be run tested at the factory.

3. These selector units must be mounted indoors.

4. When simultaneously heating and cooling, the units in heating mode to energize their sub-cooling solenoid valve.

B. Unit Cabinet:

1. These units to have a galvanized steel plate casing.

2. Each cabinet to house multiple refrigeration control valves and a liquid gas separator.

3. The cabinet to contain a tube-in-tube heat exchanger.

4. The unit to have sound absorption thermal insulation material made of flame and heat resistant foamed polyethylene.

C. Refrigerant valves:

1. Provide unit furnished with a 3-way refrigerant valve to control the direction of refrigerant flow.

2. Electronic expansion valves to be used to control the variable refrigerant flow.

3. The refrigerant connections must be of the flare type.

D. Drainage: Unit not to require condensate drainage.

E. Electrical:

1. Unit electrical power: 208/230 volts, 1 phase, 60 hertz.

2. Control voltage between the indoor and outdoor unit: 16VDC non-shielded 2 conductor cable.

2.4 BRANCH CIRCUIT (BC) CONTROLLERS (MITSUBISHI SYSTEMS)

A. General: Provide BC (Branch Circuit) Controllers specifically used with R410A R2-Series systems. Provide units equipped with a circuit board that interfaces to the M-NET controls system and to perform functions necessary for operation. The unit to have a galvanized steel finish. Provide BC Controller completely factory assembled, piped and wired. Each unit to be run tested at the factory. Mount unit indoors. The sum of connected capacity of indoor air handlers to range from 50 percent to 150 percent of rated capacity.

B. BC Unit Cabinet:

1. Casing fabricated of galvanized steel.

2. Each cabinet to house a liquid-gas separator and multiple refrigeration control valves.

3. The unit to house two tube-in-tube heat exchangers.

C. Refrigerant: R410A refrigerant required for CMB-P-NU-G/GA/GB BC Controllers in conjunction with PURY-P-TGMU-A outdoor unit systems.

D. Refrigerant valves:

1. Provide unit furnished with multiple branch circuits which can individually accommodate up to 54,000 BTUH and/or three indoor units. Branches may be twinned to allow more than 54,000 BTUH.

2. Each branch to have multiple two-position valves to control refrigerant flow.

3. Service shut-off valves field-provided/installed for each branch to allow service to any indoor unit without field interruption to overall system operation.

4. Linear electronic expansion valves to be used to control the variable refrigerant flow.

E. Integral Drain Pan: Provide an integral condensate pan and drain. A secondary drain pan piped to an observable location to be field installed.

F. Electrical:

1. Unit electrical power: 208/230 volts, 1 phase, 60 hertz.

2. Provide unit capable of satisfactory operation within voltage limits of 187-228 volts (208V/60Hz) or 207-253V (230V/60Hz).

3. BC Controller controlled by integral microprocessors.

4. Control circuit between the indoor units and the outdoor unit to be 24VDC completed using a 2-conductor, twisted pair shielded cable to provide total integration of the system.

2.5 HEAT RECOVERY UNIT (LG SYSTEMS)

A. General:

1. The sum of connected capacity of indoor air handlers to range from 50 percent to 130 percent of rated capacity.

2. The branch selector units must be run tested at the factory.

3. These selector units must be mounted indoors.

4. When simultaneously heating and cooling, the units in heating mode to energize their sub-cooling solenoid valve.

5. Units can be piped in series up to 16 tons of fan coil capacity.

B. Unit Cabinet:

1. These units to have a galvanized steel plate casing.

2. Each cabinet to house multiple refrigeration control valves and a liquid gas separator.

3. The cabinet to contain a tube-in-heat exchanger.

C. Refrigerant Valves:

1. Provide unit furnished with a 3-way refrigerant valve to control the direction of refrigerant flow.

2. Electronic expansion valves to be used to control the variable refrigerant flow.

3. Braze refrigerant connections.

D. Electrical:

1. Unit Electrical Power: 208/230 volts, 1 phase, 60 hertz.

2. Control Voltage Between the Indoor and Outdoor Unit: 16VDC shielded, stranded conductor cable.

2.6 INDOOR UNIT - WALL MOUNTED

A. General:

1. Wall-mounted indoor unit section with modulating linear expansion device matched to outdoor unit.

2. Factory assembled, wired and run tested. Factory wiring, piping, electronic modulating linear expansion device, control circuit board and fan motor. Self-diagnostic function, 3-minute time delay mechanism, auto restart function, and test run switch.

3. Indoor unit and refrigerant pipes pre-charged with dehydrated air before shipment from factory.

B. Unit Cabinet:

1. Manufacturers standard finish.

2. Multi directional drain and refrigerant piping.

3. Separate back plate to secure unit firmly to wall.

C. Fan:

1. One or two line-flow fan(s) direct driven by single motor.

2. Statically and dynamically balanced; permanently lubricated bearing motor.

3. Manual adjustable guide vane with ability to change airflow from side to side (left to right).

4. Motorized air sweep louver for automatic change in airflow by directing air up and down to provide uniform air distribution.

D. Filter:

1. Easily removable, washable or disposable return filter.

E. Evaporator Coil:

1. Nonferrous construction with smooth plate fins on copper tubing with inner grooves for high efficiency heat exchange.

2. Brazed tube joints with phos-copper or silver alloy.

3. Pressure tested at factory.

4. Condensate pan and drain under coil.

5. Insulated refrigerant lines.

F. Controls:

1. The unit to have PID controls provided by manufacturer to perform input functions necessary to operate the system. No third party building management system to be required, however, VRV/VRF system to be capable of communicating with third party BMS.

2. The unit to be compatible with interfacing with connection to LonWorks or BACnet networks.

2.7 INDOOR UNIT - CEILING CONCEALED DUCTED (HIGH STATIC)

A. General:

1. Ceiling-concealed, ducted indoor fan coil with fixed rear return and a horizontal discharge supply. Modulating linear expansion device. External static pressure settings up to 0.6-inch WC.

2. Factory assembled, wired and run tested. Factory wiring, piping electronic modulating linear expansion device, control circuit board and fan motor. Self-diagnostic function, 3-minute time delay mechanism, and auto restart function.

3. Indoor unit and refrigerant pipes precharged with dehydrated air before shipment from factory.

B. Unit Cabinet:

1. Ceiling-concealed, ducted.
2. Provisions for field installed, filtered, outside air intake.

C. Fan:

1. One or two fans direct driven by single motor.
2. Statically and dynamically balanced, motor with permanently lubricated bearings.
3. Minimum of two speed settings.
4. Fan motor to be thermally protected.

D. Filter:

1. Field-supplied return air filter.
2. Filter box with high efficiency filter as scheduled.

E. Evaporator Coil:

1. Nonferrous construction with smooth plate fins on copper tubing with inner grooves for high efficiency heat exchange.
2. Brazed tube joints with phos-copper or silver alloy.
3. Pressure tested at factory.
4. Condensate pan and drain under coil. Provide with integral condensate pump.
5. Condensate gravity drained from fan coil, with available factory condensate pump.

F. Controls:

1. The unit to have PID controls provided by manufacturer to perform input functions necessary to operate the system. No third party building management system to be required, however, VRV/VRF system to be capable of communicating with third party BMS.

2. The unit to be compatible with interfacing with connection to LonWorks or BACnet networks.

2.8 CONTROLS FOR VRV SYSTEMS

A. General:

1. Provide devices required for fully operating system including but not limited to: Remote controllers, schedule timers, system controllers, centralized controllers, integrated web based interface, graphical user workstation, and system integration to Building Management Systems via protocol established in 23 09 00, Instrumentation and Control Performance Specifications.

2. General Electrical: 24 VDC controller power and communications via common, non-polar communications bus: Main system controller capable of being networked with other system controllers for web based control.

3. Wiring type: Wiring 2-conductor (16 AWG), twisted shielded pair, and stranded wire.

4. Install controls in accordance with 23 09 00, Instrumentation and Control Performance Specifications.

B. Controls Network:

1. Controls Network consists of remote controllers, schedule timers, system controllers, centralized controllers, and integrated web based interface communicating over high-speed communication bus. Controls network support operation monitoring, scheduling, error email distribution, personal browsers, tenant billing, online maintenance support, and integration with Building Management Systems. Provide interfaces to support communication protocols specified in Section 23 09 00.

2. Simple Remote Controller: Simple Remote Controller capable of controlling up to a minimum of 12 indoor units (defined as 1 group). Controller supports temperature display selection of Fahrenheit or Celsius. Controller will allow user to change on/off, mode (cool, heat, auto, dry, and fan), temperature setting, and fan speed setting. Controller able to limit set temperature range from Simple remote controller. Room temperature sensed at either Controller or Indoor Unit dependent on indoor unit dipswitch setting. Controller will display a four-digit error code in event of system abnormality/error.

C. System Integration

1. Control system capable of supporting integration with Building Management Systems (BMS) using protocol specified in Section 23 09 00.

2. Operation and monitoring points include, but are not limited to:

    a. ON/OFF (setting).

    b. ON/OFF (status).

    c. Alarm Sign.

    d. Error Code.

    e. Operation Mode (setting).

    f. Operation Mode (status).

    g. Fan Speed (setting).

    h. Fan Speed (status).

    i. Measured Room Temperature.

    j. Set Room Temperature.

    k. Filter Limit Sign.

    l. Filter Limit Sign Reset.

    m. Remote Control Operation (ON/OFF).

    n. Remote Control Operation (Operation Mode).

    o. Remote Control Operation (Set Temperature).

    p. Electrical Total Power.

    q. Communication Status.

    r. System Forced OFF.

    s. Forced Thermostat OFF (setting).

    t. Forced Thermostat OFF (status).

    u. Compressor Status.

v. Indoor Fan Status.

w. Heater Operation Status.

PART 3 - EXECUTION

3.1 GENERAL INSTALLATION REQUIREMENTS

A. General:

1. Install all refrigerant piping and condensate tubing concealed inside wall at all wall mounted units.

B. Insulation:

1. Insulate refrigerant piping, condensate drains, drip pans, and other associated appurtenances.

C. Controls:

1. Wiring: Control wiring install in a system daisy chain configuration per manufacturer's installation instructions.

2. Control wiring for schedule timers, system controllers, and centralized controllers installed in a daisy chain configuration per manufacturer's installation instructions.

3. Control wiring for remote controllers from remote controller to first associated indoor unit then to remaining associate indoor units in a daisy chain configuration per manufacturer's installation instructions.

D. Indoor Units:

1. Connect refrigerant piping to unit, run piping so as not to interfere with access to unit. Install furnished field mounted accessories. Install per manufacturer's requirements and provide accumulator when required due to length of refrigerant piping. Install rigid, level and plumb.

2. Where manufacturer's standard condensate pump does not provide adequate lift, provide condensate pump that will meet lift requirements. Confirm unit shutdown upon failure of condensate pump.

3. Provide vibration isolation as indicated on drawings.

4. Provide condensate drainage from indoor units and branch selection devices. Provide secondary overflow pans and piping to observable location as required for concealed units.

E. Cleaning:

1. Prior to acceptance, thoroughly clean equipment, remove shipping labels and traces of foreign substance. Touch up with factory matching paint on scratched surfaces.

F. Start-Up:

1. Factory certified service representative to supervise start-up in accordance with manufacturer's instructions.

2. Make final adjustments to assure proper operation of load system. Demonstrate final set up and programming to Owner.

3. Test units in modes of operation and demonstrate compliance with requirements. Replace damaged or malfunctioning controls and equipment.

3.2 OUTDOOR UNIT (SIMULTANEOUS HEATING AND COOLING)

A. Connect refrigerant piping to unit, run piping so as not to interfere with access to unit. Install furnished field mounted accessories. Install per manufacturer's requirements and provide accumulator when required due to length of refrigerant piping. Install rigid, level and plumb.

B. Install per manufacturer's written instructions and requirements.

3.3 BRANCH SELECTOR UNITS FOR VRF HEAT RECOVERY SYSTEM (DAIKIN APPLIED SYSTEM)

A. Install per manufacturer's written instructions and requirements.

3.4 BRANCH CIRCUIT (BC) CONTROLLERS (MITSUBISHI SYSTEMS)

A. Install per manufacturer's written instructions and requirements.

3.5 HEAT RECOVERY UNIT (LG SYSTEMS)

A. Install per manufacturer's written instructions and requirements.

3.6 INDOOR UNIT - WALL MOUNTED

A. Indoor Units:

1. Connect refrigerant piping to unit, run piping so as not to interfere with access to unit. Install furnished field mounted accessories. Install per manufacturer's requirements and provide accumulator when required due to length of refrigerant piping. Install rigid, level and plumb.

2. Where manufacturer's standard condensate pump does not provide adequate lift, provide condensate pump that will meet lift requirements. Confirm unit shutdown upon failure of condensate pump.

3. Provide vibration isolation as indicated on drawings.

4. Provide condensate drainage from indoor units and branch selection devices. Provide secondary overflow pans and piping to observable location as required for concealed units.

B. Install per manufacturer's written instructions and requirements.

3.7 INDOOR UNIT - CEILING CONCEALED DUCTED (HIGH STATIC)

A. Indoor Units:

1. Connect refrigerant piping to unit, run piping so as not to interfere with access to unit. Install furnished field mounted accessories. Install per manufacturer's requirements and provide accumulator when required due to length of refrigerant piping. Install rigid, level and plumb.

2. Where manufacturer's standard condensate pump does not provide adequate lift, provide condensate pump that will meet lift requirements. Confirm unit shutdown upon failure of condensate pump.

3. Provide vibration isolation as indicated on drawings.

4. Provide condensate drainage from indoor units and branch selection devices. Provide secondary overflow pans and piping to observable location as required for concealed units.

B. Install per manufacturer's written instructions and requirements.

3.8 CONTROLS FOR VRV SYSTEMS

A. Sequence of Operation

1. Occupied Mode Operation: Indoor fan coil units operate to maintain space temperature set point. Enable associated energy recovery ventilators.

2. Unoccupied Mode Operation: Indoor fan coil units operate to maintain unoccupied space temperature set point. Disable associated energy recovery ventilators.

END OF SECTION

SECTION 23 72 23 - PACKAGED AIR-TO-AIR ENERGY RECOVERY UNITS

PART 1 - GENERAL

1.1 SUMMARY

A. Work Included:

1. Indoor Packaged Energy Recovery Ventilators

a. Factory Testing

b. Cabinet

c. Blowers

d. Fixed Plate Heat Exchanger

e. Isolation Dampers

f. Bypass Damper

g. Filter

h. Pre-Heater

i. Electrical

j. Controls

1.2 RELATED SECTIONS

A. Contents of Division 23, HVAC and Division 01, General Requirements apply to this Section.

1.3 REFERENCES AND STANDARDS

A. References and Standards as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.

B. In addition, meet the following:

1. AHRI 270 - Sound Performance Rating of Outdoor Unitary Equipment (with Addendum 1).

2. AHRI 410 - Forced-Circulation Air-Cooling and Air-Heating Coils (with Addenda 1, 2 & 3).

3. ANSI/AHRI Standard 340/360 - Performance Rating of Commercial and Industrial Unitary Air-Conditioning and Heat Pump Equipment.

4. AHRI 1060 I-P - Performance Rating of Air-to-Air Exchangers for Energy Recovery Ventilation Equipment.

5. ASHRAE Standard 84 - Method of Testing Air-to-Air Heat/Energy Exchangers.

1.4 SUBMITTALS

A. Submittals as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.

B. In addition, provide:

1. Product Literature: Indicate dimensions, weights, capacities, ratings, gauges and finishes of materials, electrical characteristics and connection requirements.

2. Certified fan performance curves with system operating conditions indicated.

3. Certified fan sound-power ratings.

4. Filters: Data for filter media, filter performance data.

5. Electrical Requirements: Power supply wiring including wiring diagrams for interlock and control wiring, clearly indicating factory-installed and field-installed wiring.

1.5 QUALITY ASSURANCE

A. Quality assurance as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.

B. In addition, meet the following:

1. Interior surfaces of units meet erosion and growth resistance requirements of ASHRAE 62.1, latest edition, as well as construction requirements for equipment.

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

3. Fabricate and label refrigeration system to comply with ASHRAE 15, "Safety Code for Mechanical Refrigeration."

4. Energy-Efficiency Ratio: Meet minimum requirements shown on drawings.

5. Coefficient of Performance: Meet minimum requirements shown on drawings.
6. AHRI Certification: Provide AHRI certified and listed units.
7. Sound Power Level Ratings: Comply with AHRI 270, Sound Performance Rating of Outdoor Unitary Equipment (with Addendum 1).
8. Provide coils performing to AHRI 410 Standards.
9. Entire unit to be ETL Certified per UL Standard 1995 and bear an ETL sticker.
10. Energy wheel to be AHRI 1060 I-P certified.
11. Performance: Scheduled capacities and face areas are minimum accepted values. Scheduled amps, kW, and HP are maximum accepted values that allow scheduled capacity to be met.

1.6 WARRANTY

A. Warranty of materials and workmanship as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.

1.7 EXTRA MATERIAL

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Filters: One set of filters for each unit.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. The following manufacturers will be considered provided they comply with Contract Documents.

B. Indoor Packaged Energy Recovery Ventilators:

1. Mitsubishi
2. LG
3. Renewaire
4. Ventacity

5. Or approved equivalent.

2.2 INDOOR PACKAGED ENERGY RECOVERY VENTILATORS

A. Factory Testing:

1. The unit will be factory assembled, wired and run tested.

B. Unit Cabinet:

1. The cabinet will be fabricated of galvanized steel.
2. Insulated with 2-inch-thick, 3/4-pound density, neoprene-coated glass fiber or polyurethane foam insulation.

C. Blowers:

1. Furnish with direct drive centrifugal blowers for supply and exhaust.
2. Blower motors directly connected to the blower wheels and have permanently lubricated bearings.
3. Blowers and motors mounted on isolators for quiet operation.

D. Fixed Plate Heat Exchanger:

1. Heat exchanger element constructed of specially treated cellulose fiber membrane separated by corrugated layers or aluminum to allow sensible and latent energy recovery.

E. Isolation Dampers:

1. Provide low leak insulated dampers on exhaust and outside air with actuators interlocked with fan operation.

F. Bypass Damper:

1. The unit to have an automatic supply side bypass damper to allow inbound ventilation air to bypass the energy transfer core for economizer operation.
2. Supply and return air thermistor will control the damper.

G. Filter:

1. The heat exchanger will have protective filters installed at both the supply and exhaust sides with an access cover to allow easy maintenance.

2. Provide MERV 8 filters.

H. Pre-Heater:

1. Provide integral electric heater for frost protection.

I. Electrical:

1. Unit wiring to comply with NEC requirements and applicable UL standards. Unit to have single point power terminal block for main power connection.

2. The unit manufacturer to install power and control wiring.

3. Provide ground fault detection.

J. Controls:

1. Provide unit controller capable of stand-alone operation. Unit control system to perform unit control functions including scheduling, unit diagnostics and safeties. Unit controller, and sensors to be factory mounted, wired and tested.

2. Provide controller with display for unit configuration, set point adjustment, sensor status viewing, unit alarm viewing, and occupancy scheduling.

3. Provide external control from VRV centralized controller or BMS.

4. Controller provides the following functions:

a. Heat recovery mode: Ventilation air and exhaust air pass through energy recovery core and bypasses are closed.

b. Bypass mode: Return air bypasses the core and is exhausted.

c. Auto mode; automatically changes between the bypass and heat recovery modes based on space and outside air temperature.

d. Night purge.

e. Adjustable fan speed control.

f. Scheduling.

PART 3 - EXECUTION

3.1 INDOOR PACKAGED ENERGY RECOVERY VENTILATORS

A. General Installation Requirements:

1. Install in accordance with manufacturer's instructions.

2. Use touch-up paint to repair scratches and minor damage to equipment prior to startup.

3. Provide seismic restraint, as necessary.

4. Install with required clearances and access for maintenance.

5. Install factory furnished devices for field installation.

B. Pre-Heater:

1. Remove debris and clean heating elements.

C. Electrical:

1. Electrical System Connections: Comply with applicable requirements in Division 26, Electrical Sections for power wiring, switches, and motor controls.

2. Ground equipment according to Division 26, Electrical.

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

D. Controls:

1. Connect to BMS or VRV Controller.

E. Field Quality Control:

1. Inspect for and remove shipping bolts, block and tie-down straps.

2. After energizing units: Test units for proper fan rotation. Test and adjust controls and internal safeties.

3. Replace malfunctioning units and retest.

4. Thoroughly clean exposed portions of equipment. Install new filters prior to final test and balance and again prior to final acceptance.

END OF SECTION

SECTION 23 81 26 - SMALL SPLIT SYSTEM AND UNITARY HVAC EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Work Included: Materials, installation and testing of:

1. Ductless Split Systems - Cooling Only
2. Split System Condensing Unit
3. Split System Indoor Fan Coil Unit

1.2 RELATED SECTIONS

A. Contents of Section 23 00 00, HVAC Basic Requirements and Division 1, General Requirements apply to this Section.

1.3 REFERENCES AND STANDARDS

A. References and Standards as required by Section 23 00 00, HVAC Basic Requirements and Division 1, General Requirements.

B. In addition, meet the following:

1. AHRI 210/240 - Performance Rating of Unitary Air-Conditioning and Air-Source Heat Pump Equipment.

1.4 SUBMITTALS

A. Submittals as required by Section 23 00 00, HVAC Basic Requirements and Division 1, General Requirements.

1.5 QUALITY ASSURANCE

A. Quality assurance as required by Section 23 00 00, HVAC Basic Requirements and Division 1, General Requirements.

B. In addition, meet the following:

1. Efficiency ratings, cooling/heating performance, fan performance, sound performance to meet or exceed Basis of Design as scheduled on Drawings.

1.6 WARRANTY

A. Warranty of materials and workmanship as required by Section 23 00 00, HVAC Basic Requirements and Division 1, General Requirements.

B. In addition, provide:

1. Refrigeration compressor(s): 5-year warranty.
2. Furnace heat exchanger: 5-year warranty.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Ductless Split Systems:

1. Mitsubishi
2. Sanyo
3. Daikin Applied
4. LG
5. Or approved equivalent.

B. Split System Condensing Unit:

1. Johnson Controls
2. Trane
3. Daikin
4. LG
5. Or approved equivalent.

C. Split System Indoor Fan Coil Unit:

1. Trane
2. Johnson Controls
3. Daikin
4. LG
5. Or approved equivalent.

2.2 DUCTLESS SPLIT SYSTEMS - COOLING ONLY

A. Description: Self-contained, matched factory-engineered and assembled. Pre-wired indoor and outdoor units. UL/ETL listed.

B. Outdoor Unit:

1. Self contained, consisting of cabinet, compressor system, condenser fan matched to indoor unit.

2. Cabinet: Fabricated of galvanized steel, bonderized, and finished with powder coated baked enamel.

3. Refrigerant System:

    a. HFC refrigerant or other refrigerant with zero ozone depletion potential (ODP).

    b. Compressor: To be inverter driven, hermetic rotary type.

4. Air System:

    a. Fan: Propeller Type with one direct drive, inverter driven, variable speed motor.

    b. Motor: Premium efficiency with inherent protection, permanently lubricated bearings and variable speed drive compatible.

    c. Coil: Copper tubes and aluminum fins, coated for corrosion protection.

5. Controls: Single source for both indoor and outdoor units, with low/high pressure switch, capable of communicating to/from the building DDC control system.

C. Indoor Unit(s):

1. Self contained wall mounted, ceiling mounted, or recessed ceiling mounted evaporator unit(s) matched to outdoor unit.

2. Cabinet:

    a. Non-flammable, high impact polymer with a white finish.

    b. Power Source: To be a single point power connection or sub-fed from outdoor condensing unit.

3. Refrigeration System: HFC refrigerant or other refrigerant with zero ozone depletion potential (ODP).

4. Air System:

    a. Fan: An assembly with one or two inline fan(s) with a single direct drive motor.

    b. Filter: Polypropylene, furnished with the unit, removable and washable.

    c. Coil: Direct expansion type with copper tubes mechanically bonded into aluminum fins.

5. Condensate Drain:

    a. Provide drain pan sloped to drain away from unit. Drain pan with a single drain connection.

    b. Condensate pump kit provided with unit.

    c. Secondary drain pan; Condensate overflow shut-off float switch and external alarm.

6. Controls: Wired thermostat. Control to be integral with unit.

2.3 SPLIT-SYSTEM CONDENSING UNIT

A. Description: Cooling operation, Energy Star labeled. Unit matched to indoor evaporator fan unit, coil, furnace, low ambient operation to 40 degrees F, or vibration isolators.

B. Cabinet: Fabricated of galvanized steel and finished with powder coated baked enamel with Coastal Coating for corrosion resistance or Hail Guard.

C. Refrigeration System:

1. HFC Refrigerant or other refrigerant with zero ozone depletion potential (ODP).

2. Hermetically sealed compressor, high efficiency, 2-stage operation, variable speed compressor, integral high/low pressure and temperature protection, liquid line filter dryer.

3. Options:

    a. Long line accessory kit.

    b. Solenoid valve.

    c. Crankcase heater.

D. Condenser Air System:

1. Condenser Fan: Propeller type with direct drive motor, low sound generator, variable speed condenser fan.

2. Condenser Fan Motor: Premium efficiency, permanently lubricated, totally enclosed with built-in current and thermal overload protection.

3. Condenser Coil: Copper tubes mechanically bonded into aluminum fins.

   a. Provide corrosion protection coating.

   b. Provide Hail Guard.

E. Condensate: Collection in galvanized steel drain pan sloped to drain away from the unit.

F. Controls: Completely internally wired, microprocessor, high and low pressure cutouts, contractors and internal overload protection on all motors. Provide low ambient operation to 40 degrees F outside to maintain condensing temperature on part load operation. Provide anti-short cycle timer and time delay between compressor operation.

2.4 SPLIT-SYSTEM INDOOR FAN COIL UNIT

A. Indoor fan unit matched to outdoor condensing unit. Self-contained, packaged, factory-assembled, pre-wired unit with direct expansion evaporator coil, cabinet supply fan, filter housing and controls. Accessories, economizer assembly, etc. as scheduled and shown on Drawings.

B. Components:

1. Steel cabinet with baked enamel finish or galvanized steel; minimum 1/2-inch thick, 1-1/2# liner with cleanable facing or solid interior metal panel, filter housing suitable for 1-inch or 2-inch thick filter. Easily removed access panels.

2. Economizer/Mixing Box with damper actuator.

C. Refrigeration System: HFC Refrigerant or other refrigerant with zero ozone depletion potential (ODP).

D. Air System:

1. Supply Fan (Evaporator Fan): centrifugal multi-speed direct drive, ECM motor drive, or V-belt with internal vibration isolation.

2. Evaporator Motor: Premium efficiency with permanently lubricated bearings thermal overload protection. Provide optional high static motor.

3. Evaporator Coil: Seamless copper tubes expanded into aluminum fins. Galvanized or polymer drain pan sloped in all directions.

4. Filter: MERV 8, 1-inch thick, pleated, throw-away.

5. Supplemental Heat Coil:

    a. Electric Heat Coil: UL Listed with helix wound bare nichrome wire heating elements. Heat output and staging as scheduled. Power usage per stage is not to exceed 5 kilowatts. Staging of coil heat internally controlled.

    b. Hot water coil: copper tubes mechanically bonded into aluminum fins, arranged for counter flow.

E. Condensate:

1. Condensate pump kit.

2. Secondary drain pan; condensate overflow shut-off float switch and external alarm.

F. Controls: Factory-wired to internal terminal strip or board for connection to programmable thermostat or Building Management System (BMS).

G. Electrical: Furnish magnetic contactors. Arrange for single point electrical connection. Provide all associated field wiring.

PART 3 - EXECUTION

3.1 GENERAL INSTALLATION REQUIREMENTS

A. Install with required clearances and access for maintenance.

B. Install factory furnished devices for field installation.

C. Inspect for and remove shipping bolts, blocks and tie-down straps.

D. After energizing units: Test units for proper fan rotation. Test and adjust controls and internal safeties. Replace malfunctioning units and retest.

E. Thoroughly clean exposed portions of equipment. Install new filters prior to final test and balance and again prior to final acceptance.

F. Provide vibration isolation: As scheduled.

G. Provide seismic restraint.

H. Condensate drain per manufacturer's piping diagram.

I. Condensate piped to indirect waste connection; cleanouts at changes of direction; sized and sloped to drain per Code.

J. Shut-off/hose kits for all hydronic connections.

END OF SECTION

SECTION 23 82 00 - TERMINAL HEAT TRANSFER EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Work Included:

1. Electric Wall Heaters

1.2 RELATED SECTIONS

A. Contents of Division 23, HVAC and Division 01, General Requirements apply to this Section.

1.3 REFERENCES AND STANDARDS

A. References and Standards as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.

1.4 SUBMITTALS

A. Submittals as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.

1.5 QUALITY ASSURANCE

A. Quality assurance as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.

1.6 WARRANTY

A. Warranty of materials and workmanship as outlined in Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Electric Wall Heaters:

1. Trane

2. Markel

3. Qmark

4. Chromalox

5. Indeeco

6. Or approved equivalent.

2.2 ELECTRIC WALL HEATERS

A. Description: Wall mounted forced air unit heater, including enclosure for recessed mounting, fan and motor, heating elements and wall box. UL listed and wired per NEC.

B. Cabinet: 20 gauge zinc coated steel, 16 gauge painted exterior grille.

C. Fan and Motor: Propeller type fan, totally enclosed motor with permanently lubricated bearings and thermal overload protection, vandal proof.

D. Heating Element: Sealed tubular type with finned heating elements, manual reset thermal limit safety switch, fan purge limit to dissipate residual heat on heater shutdown.

E. Control:

1. Built-in thermostat with accessible disconnect switch.

PART 3 - EXECUTION

3.1 GENERAL INSTALLATION REQUIREMENTS

A. Avoid interference with structure and with work of other trades, preserving adequate headroom and clearing doors and passageways. Check each piece of equipment for defects, verifying that items function properly and that adjustments have been made.

B. Prior to acceptance, thoroughly clean exposed portions of terminal heat transfer equipment, remove shipping labels and traces of foreign substance. Touch up scratched surfaces of radiant panels with factory matching paint.

3.2 ELECTRIC WALL HEATERS INSTALLATION

A. Damaged Coils: Make every effort to prevent damage to both built-up coils and coils of packaged equipment. Comb damaged coil fins to be straight.

B. Install per manufacturer's instructions. Comply with NEC and UL listings.

C. Install heaters in place with box trim flush with finished wall.

D. Install thermostat as shown on drawings. Provide control wiring from thermostat to unit.

END OF SECTION

SECTION 40 05 10 – PROCESS PIPING AND FITTING GENERAL REQUIREMENT

PART 1 GENERAL

1.1 SUMMARY

A. The Contractor shall furnish and install all piping systems shown and specified, in accordance with the requirements of the Contract Documents. Each system shall be complete with all necessary fittings, hangers, supports, anchors, expansion joints, flexible connectors, valves, accessories, heat tracing, insulation, lining and coating, testing, disinfection, excavation, backfill and encasement, to provide a functional installation.

B. The piping shown is intended to define the general layout, configuration, routing, method of support, pipe size, and pipe type. The mechanical drawings are not pipe construction or fabrication drawings. It is the Contractor's responsibility to develop the details necessary to construct all mechanical piping systems, to accommodate the specific equipment provided, and to provide and install all spools, spacers, adapters, connectors, etc., for a complete and functional system.

1.2 REFERENCE STANDARDS

A. Commercial Standards:

ANSI/ASME B1.20.1	Pipe Threads, General Purpose (inch)
ANSI B16.5	Pipe Flanges and Flanged Fittings, Steel Nickel Alloy and other Special Alloys
ANSI/AWWA C207	Steel Pipe Flanges for Water Works Service, Sizes 4 in through 144 in.
ANSI/AWWA C606	Grooved and Shouldered Joints
ANSI/AWS D1.1	Structural Welding Code
ASTM A 307	Specification for Carbon Steel Bolts and Studs, 6,000 psi Tensile
ASTM A 325	Specification for High-Strength Bolts for Structural Steel Joints
ASTM A53	Standard Specification for Ductile Iron Castings.
ASTM D 792	Test Methods for Specific Gravity and Density of Plastics by Displacement

ASTM D 2000	Classification System for Rubber Products in Automotive Applications
ANSI/NSF 61	Drinking Water System Components

1.3 SUBMITTALS

A. The Contractor shall submit complete shop drawings and certificates, test reports, affidavits of compliance, of all piping systems, in accordance with the requirements in Section 01 33 00- Submittal Procedures, and as specified in the individual piping sections.

The shop drawings shall include all necessary dimensions and details on pipe joints, fittings, fitting specials, valves, appurtenances, design calculations, and material lists. The submittals shall include detailed layout, spool, or fabrication drawings which show all pipe spools, spacers, adapters, connectors, fittings, and pipe supports necessary to accommodate the equipment and valves provided in a complete and functional system.

B. All expenses incurred in making samples for certification of tests shall be borne by the Contractor.

C. The Contractor shall submit as part of the shop drawings a statement from the pipe fabricator certifying that all pipes will be fabricated subject to a recognized Quality Control Program. An outline of the program shall be submitted to the Engineer for review prior to the fabrication of any pipe.

D. ANSI/NSF61 certification is required for all potable water piping.

1.4 QUALITY ASSURANCE

A. Inspection: All pipe shall be subject to inspection at the place of manufacture. During the manufacture of the pipe, the Engineer shall be given access to all areas where manufacturing is in progress and shall be permitted to make all inspections necessary to confirm compliance with the Specifications.

B. Tests: Except where otherwise specified, all materials used in the manufacture of the pipe shall be tested in accordance with the applicable Specifications and Standards. Welds shall be tested as specified. The Contractor shall perform all tests at no additional cost to the Owner.

C. Welding Requirements: All welding procedures used to fabricate pipe shall be prequalified under the provisions of ANSI/AWS D1.1. Welding procedures shall be required for, but not necessarily limited to, longitudinal and girth or spiral welds for pipe cylinders, spigot and bell ring attachments, reinforcing plates and ring flange welds, and plates for lug connections.

D. Welder Qualifications: All welding shall be done by skilled welders, welding operators, and tackers who have had adequate experience in the methods and materials to be used. Welders shall be qualified under the provisions of ANSI/AWS D1.1 by an independent local, approved testing agency not more than 6 months prior to commencing work on the pipeline. Machines and electrodes similar to those used in the work shall be used in qualification tests. The Contractor shall furnish all material and bear the expense of qualifying welders.

PART 2 PRODUCTS

2.1 GENERAL

A. Pipe Supports: All pipes shall be adequately supported in accordance with the requirements of Section 40 05 07 – Hangers and Supports for Process Piping.

B. Lining: All requirements pertaining to thickness, application, and curing of pipe lining, are in accordance with the requirements of the applicable industrial standards.

C. Coating: All requirements pertaining to thickness, application, and curing of pipe coating, are in accordance with the requirements of the applicable industrial standards, unless otherwise specified. Pipes above ground or in structures shall be field painted in accordance with Section 09 90 00.

D. Pressure Rating: All piping systems shall be designed for the maximum expected pressure as shown on the piping schedule.

E. Grooved Piping Systems: Piping systems with grooved joints and fittings may be provided in lieu of screwed, flanged, welded, or mechanical joint systems for steel and ductile iron yard piping. (All piping above and below ground within the property limits of treatment plants, pump stations, and similar installations). All grooved couplings on buried piping must be bonded. To assure uniform and compatible piping components, all grooved fittings, couplings, and valves shall be from the same manufacturer. The Contractor shall make the coupling manufacturer responsible for the selection of the correct style of coupling and gasket for each individual location.

F. All piping material in direct contact with potable water must be ANSI/NSF61 certified.

2.2 PIPE FLANGES

A. Flanges: Where the design pressure is 150 pounds per square inch (psi) or less, flanges shall conform to either ANSI/AWWA C207 Class D or ANSI B16.5 150-pound class. Where the design pressure is greater than 150 psi, up to a maximum of 275 psi, flanges shall conform to either ANSI/AWWA C207 Class E, Class F, or ANSI B16.5 150-pound class. Where the design pressure is greater than 275 psi up to a maximum of 700 psi, flanges shall conform to ANSI B16.5 300-pound class. Flanges shall have flat faces and shall be attached with bolt holes straddling the vertical axis of the pipe unless otherwise shown. Attachment of the flanges to the pipe shall conform to the applicable requirements of ANSI/AWWA C207. Flanges for miscellaneous small pipes shall be in accordance with the standards specified for these pipes.

B. Blind Flanges: Blind flanges shall be in accordance with ANSI/AWWA C207, or with the standards for miscellaneous small pipes. All blind flanges for pipe sizes 12 inches and over shall be provided with lifting eyes in form of welded or screwed eye bolts.

C. Flange Coating: All machined faces of metal blind flanges and pipe flanges shall be coated with a temporary rust-inhibitive coating to protect the metal until the installation is completed.

D. Flange Bolts: All bolts and nuts shall conform to Section 05 50 00 –Metal Fabrications. Studs and bolts shall extend through the nuts a minimum of 1/4-inch. All- thread studs shall be used on all valve flange connections, where space restrictions preclude the use of regular bolts.

E. Insulating Flanges: Insulated flanges shall have bolt holes 1/4-inch diameter greater than the bolt diameter.

F. Insulating Flange Sets: Insulating flange sets shall be provided where shown. Each insulating flange set shall consist of an insulating gasket, insulating sleeves and washers and a steel washer. Insulating sleeves and washers shall be one piece when flange bolt diameter is 1-1/2-inch or smaller and shall be made of acetal resin. For bolt diameters larger than 1-1/2-inch, insulating sleeves and washers shall be two-piece and shall be made of polyethylene or phenolic. Steel washers shall be in accordance with ASTM A 325. insulating gaskets shall be full-face.

G. Insulating Flange Manufacturers, or Equal:

1. JM Red Devil, Type E
2. Maloney Pipeline Products Co., Houston
3. PSI Products, Inc., Burbank, California

H. Flange Gaskets: Gaskets for flanged joints shall be full-faced, 1/16-inch thick compressed sheets of aramid fiber base, with nitrite binder and non-stick coating, suitable for temperatures to 700 degrees Fahrenheit (F), a pH of one to eleven, and pressures to 1000 pounds per square inch gauge (psig). Blind flanges shall have gaskets covering the entire inside face of the blind flange and shall be cemented to the blind flange. Ring gaskets shall not be permitted.

I. Flange Gasket Manufacturers, or Equal:

1. John Crane, style 2160
2. Garlock, style 3000

2.3 THREADED INSULATING CONNECTIONS

A. General: Threaded insulating bushings, unions, or couplings, as appropriate, shall be used for joining threaded pipes of dissimilar metals and for piping systems where corrosion control and cathodic protection are involved.

B. Materials: Threaded insulating connections shall be of nylon, Teflon, polycarbonate, polyethylene, or other non-conductive materials, and shall have ratings and properties to suit the service and loading conditions.

2.4 MECHANICAL-TYPE COUPLINGS (GROOVED OR BANDED PIPE)

A. General: Cast mechanical-type couplings shall be provided where shown. The couplings shall conform to the requirements of ANSI/AWWA C606. Bolts and nuts shall conform to the requirements of Section 05 50 00 - Metal Fabrications. All gaskets for mechanical-type couplings shall be compatible with the piping service and fluid utilized, in accordance with the coupling manufacturer's recommendations. The wall thickness of all grooved piping shall conform with the coupling manufacturer's recommendations to suit the highest expected pressure. To avoid stress on equipment, all equipment connections shall have rigid-grooved couplings, or harness sets in sizes where rigid couplings are not available, unless thrust restraint is provided by other means. The Contractor shall have the coupling Manufacturer's service representative verify the correct choice and application of all couplings and gaskets, and the workmanship, to assure a correct installation.

B. Couplings for Steel Pipe, Manufacturers, or Equal:

1. Gustin-Bacon (banded or grooved)
2. Victaulic Style 41 or 44 (banded, flexible)
3. Victaulic Style 77 (grooved, flexible)
4. Victaulic Style 07 or HP-70 (grooved, rigid)

C. Ductile Iron Pipe Couplings, Manufacturers, or Equal:

1. Gustin-Bacon
2. Victaulic Style 31 (flexible or rigid grooving)

Note: Ductile iron pipe couplings shall be furnished with flush seal gaskets.

D. Couplings for polyvinyl chloride (PVC) Pipe, Manufacturers, or Equal:

1. Gustin-Bacon
2. Victaulic Style 775

Note: Couplings for PVC pipe shall be furnished with radius cut or standard roll grooved pipe ends.

E. Flanged Mechanical Joint Coupling with Cam-Lock Joint Restraint:

1. Smith-Blair Product No. 911. Shall have a pressure rating of 150 psi and a safety factor of 1.5:1 with a fusion bonded epoxy coating per AWWA C213

2.5 SLEEVE-TYPE COUPLINGS

A. Construction: Sleeve-type couplings shall be provided where shown, in accordance with ANSI/AWWA C219 unless otherwise specified, and shall be of steel with steel bolts, without pipe stop, and shall be of sizes to fit the pipe and fittings shown. The middle ring shall be not less than 1/4-inch in thickness and shall be either 5 or 7 inches long for sizes up to and including 30 inches and 10 inches long for sizes greater than 30 inches, for standard steel couplings, and 16 inches long for long-sleeve couplings. The followers shall be single-piece contoured mill section welded and cold-expanded as required for the middle rings. They shall be of sufficient strength to accommodate the number of bolts necessary to obtain adequate gasket pressure without excessive "oiling". The shape of the follower shall be of such design as to provide positive confinement of the gasket. Bolts and nuts shall conform to the requirements of Section 05 50 00 –Metal Fabrications. Buried sleeve-type couplings shall be epoxy-coated at the factory as specified.

B. Pipe Preparation: The ends of the pipe, where specified or shown, shall be prepared for flexible steel couplings. Plain ends for use with couplings shall be smooth and round fora distance of 12 inches from the ends of the pipe, with outside diameter not more than 1/64-inch smaller than the nominal outside diameter of the pipe. The middle ring shall be tested by cold-expanding a minimum of one percent beyond the yield point, to proof-test the weld to the strength of the parent metal. The weld of the middle ring shall be subjected to air test for porosity.

C. Gaskets: Gaskets for sleeve-type couplings shall be rubber-compound material that will not deteriorate from age or exposure to air under normal storage or use conditions. Gaskets for wastewater and sewerage applications shall be Buna "N," grade 60, or equivalent suitable elastomer. The rubber in the gasket shall meet the following specifications:

1. Color - Jet Black
2. Surface - Non-blooming
3. Durometer Hardness - 74 ± 5
4. Tensile Strength -1000 psi Minimum
5. Elongation -175 percent Minimum

The gaskets shall be immune to attack by impurities normally found in water or wastewater. All gaskets shall meet the requirements of ASTM D 2000, AA709Z, meeting Suffix B13 Grade 3, except as noted above. All gaskets shall be compatible with the piping service and fluid utilized.

D. Insulating Couplings: Where insulating couplings are required, both ends of the coupling shall have a wedge-shaped gasket which assembles over a rubber sleeve of an insulating compound in order to obtain insulation of all coupling metal parts from the pipe.

E. Restrained Joints: All sleeve-type couplings on pressure lines shall be harnessed unless thrust restraint is provided by other means. Harnesses shall be in accordance with the requirements of the appropriate reference standard, or as shown.

F. Manufacturers, or Equal:

1. Dresser, Style 38
2. Ford Meter Box Co., Inc., Style FC1 or FC3
3. Smith-Blair, Style 411

2.6 FLEXIBLE CONNECTORS

A. Flexible connectors shall be installed in all piping connections to engines, blowers, compressors, and other vibrating equipment, and where shown. Flexible connectors for service temperatures up to 180 degrees F shall be flanged, reinforced Neoprene or Butyl spools, rated for a working pressure of 40 to 150 psi, or reinforced, flanged duck and rubber, as best suited for the application. Flexible connectors for service temperatures above 180 degrees F shall be flanged, braided stainless steel spools with inner, annular, corrugated stainless steel hose, rated for minimum 150 psi working pressure, unless otherwise shown. The connectors shall be 9 inches long, face-to-face flanges, unless otherwise shown. The final material selection shall be approved by the manufacturer. The Contractor shall submit manufacturer's shop drawings and calculations.

2.7 EXPANSION JOINTS

A. All piping subject to expansion and contraction shall be provided with sufficient means to compensate for such movement, without exertion of undue forces to equipment or structures. This may be accomplished with expansion loops, bellow-type expansion joints, or sliding-type expansion joints. Expansion joints shall be of stainless steel, monel, rubber, or other materials, best suited for each individual service. The Contractor shall submit detailed calculations and manufacturer's shop drawings, guaranteeing satisfactory performance of all proposed expansion joints, piping layouts showing all anchors and guides, and information on materials, temperature and pressure ratings. -

2.8 PIPE THREADS

A. All pipe threads shall be in accordance with ANSI/ASME B1.20.

2.9 PIPE INSULATION

A. Pipe insulation shall be in accordance with the requirements of Section 40 42 13 – Process Piping Insulation.

2.10 AIR AND GAS TRAPS

A. Air and gas pipes shall be sloping to low points, provided with drip legs, shut-off valves, strainers and traps. The traps shall be piped to the nearest drain. Air and gas traps shall be not less than 150-pound iron body float type with copper or stainless steel float. Bracket, lever, and pins shall be of stainless steel. Drain traps shall have threaded connections.

B. Manufacturers, or Equal:

1. Armstrong Machine Works
2. Spirax Sarco, Inc.

PART 3 EXECUTION

3.1 DELIVERY, STORAGE, AND PROTECTION

A. All piping materials, fittings, valves, and accessories shall be delivered in a clean and undamaged condition and stored off the ground, to provide protection against oxidation. All defective or damaged materials shall be replaced with new materials. All pipe and fittings with mortar lining shall be protected from drying out either in shipping or storage. The Contractor shall periodically check all stored mortar lined pipe and fittings for adequate moisture and add water as necessary

B. Flanges: Securely attach metal, hardboard, or wood protectors over entire gasket surface.

C. Threaded or Socket Welding Ends: Fit with metal, wood, or plastic plugs or caps.

D. Linings and Coatings: Prevent excessive drying.

E. Cold Weather Storage: Locate products to prevent coating from freezing to ground.

F. Handling: Use heavy canvas or nylon slings to lift pipe and fittings.

3.2 CLEANUP

A. After completion of the work, all remaining pipe cuttings, joining and wrapping materials, and other scattered debris, shall be removed from the site. The entire piping system shall be handed over in a clean and functional condition.

3.3 INSTALLATION

A. Where core drilling is required for pipes passing through existing concrete, core drilling locations shall be determined by radiograph of concrete construction to avoid damage to embedded raceways and rebars.

B. Join pipe and fittings in accordance with manufacturer's instructions, unless otherwise shown or specified.

C. Remove foreign objects prior to assembly and installation.

D. Flanged Joints:

1. Install perpendicular to pipe centerline.
2. Bolt Holes: Straddle vertical centerlines, aligned with connecting equipment flanges or as shown.
3. Use torque-limiting wrenches to ensure uniform bearing and proper bolt tightness.
4. Plastic Flanges: Install annular ring filler gasket at joints of raised-face flange.
5. Grooved Joint Flange Adapters: Include stainless steel washer plates as required for mating to serrated faces and lined valves and equipment.
6. Raised-Face Flanges: Use flat-face flange when joining with flat-faced ductile or cast-iron flange.
7. Verify compatibility of mating flange to adapter flange gasket prior to selecting grooved adapter flanging.
8. Flange fillers are to be avoided, but if necessary, may be used to make up for small angles up to 6 degrees and for filling gaps up to 2 inches between flanges. Stacked flange fillers shall not be used.
9. Threaded flanged joints shall be shop fabricated and delivered to Site with flanges in-place and properly faced.

E. Threaded and Coupled Joints:

1. Conform to ASME B1.20.1.
2. Produce sufficient thread length to ensure full engagement when screwed home in fittings.
3. Countersink pipe ends, ream and clean chips, and burrs after threading.

4. Make connections with not more than three threads exposed.

5. Lubricate male threads only with thread lubricant or tape as specified on Piping Data Sheets.

F. Grooved-End Joints:

1. Piping shall be grooved in accordance with manufacturer's latest published instructions and shall be accurately cut with tools conforming to coupling manufacturer's standards and to AWWA C606.

2. Install grooved joint couplings and gaskets in accordance with manufacturer's latest published installation instructions.

G. Soldered Joints:

1. Use only solder specified for particular service.

2. Cut pipe ends square and remove fins and burrs.

3. After thoroughly cleaning pipe and fitting of oil and grease using solvent and emery cloth, apply noncorrosive flux to the male end only.

4. Wipe excess solder from exterior of joint before hardened.

5. Before soldering, remove stems and washers from solder joint valves.

H. PVC and chlorinated polyvinyl chloride (CPVC) Piping:

1. Provide Schedule 80 threaded nipple where necessary to connect to threaded valve or fitting.

2. Use strap wrench for tightening threaded plastic joints. Do not overtighten fittings.

3. Do not thread Schedule 40 pipe.

I. Ductile Iron Piping:

1. Cutting Pipe: Cut pipe with milling type cutter, rolling pipe cutter, or abrasive blade cutter. Do not flame cut.

2. Dressing Cut Ends:

   a. General: As required for the type of joint to be made.

   b. Rubber Gasketed Joints: Remove sharp edges or projections.

c. Push-On Joints: Bevel, as recommended by pipe manufacturer.

d. Flexible Couplings, Flanged Coupling Adapters, and Grooved End Pipe Couplings: As recommended by the coupling or adapter manufacturer.

J. Polyvinylidene fluoride (PVDF)-Lined Steel Pipe Installation:

1. Cut, make up, and install pipe in accordance with pipe manufacturer's written instructions.

2. Weld vent extension half-couplings in-place prior to lining pipe.

3. Do not weld on pipe after lining is installed.

4. Prevent plugging of vent extensions with insulation or paint.

K. High-Density Polyethylene Piping:

1. Join pipes, fittings, and flange connections by means of thermal butt-fusion.

2. Perform butt-fusion in accordance with pipe manufacturer's recommendations as to equipment and technique.

3. Special Precautions at Flanges: Polyethylene pipe connected to heavy fittings, manholes, and rigid structures shall be supported in such a manner that no subsequent relative movement between polyethylene pipe at flanged joint and rigid structures is possible.

L. Fiberglass Reinforced Piping (FRP):

1. Cut, fabricate, and install in accordance with manufacturer's written instructions.

2. Provide manufacturer's representative for instructing workers on proper installation and jointing methods.

3. Installation shall be made by workers experienced in FRP pipe lay-up techniques.

3.4 PIPELINE TESTING

A. All pipes shall be tested in accordance with Section 40 80 01 –Process Piping Testing.

3.5 MANUFACTURER'S SERVICES

A. Where the assistance of a manufacturer's service representative is advisable, in order to obtain perfect pipe joints, supports, or special connections, the Contractor shall furnish such assistance at no additional cost to the Owner.

END OF SECTION

SECTION 40 05 10.01 – DUCTILE IRON PIPE AND FITTINGS

PART 1 GENERAL

1.1 SUMMARY

A. The Contractor shall furnish and install ductile iron pipe and all appurtenant work, complete in place, all in accordance with the requirements of the Contract Documents.

B. Pipe Types:

1. CLDI, Cement-mortar Lined Ductile Iron
2. GLDI, Glass Lined Ductile Iron

1.2 REFERENCE STANDARDS

A. ANSI/AWWA C104/A21.4 Cement-Mortar Lining for Ductile-Iron Pipe and Fittings for Water

B. ANSI/AWWA C105/A21.5 Polyethylene Encasement for Ductile-Iron Piping for Water and Other Liquids

C. ANSI/AWWA C110/A21.10Ductile-Iron and Gray-Iron Fittings, 3 in Through 48 in for Water and Other Liquids

D. ANSI/AWWA C111/A21.11Rubber-Gasket Joints for Ductile-Iron and Gray-Iron Pressure Pipe and Fittings

E. ANSI/AWWA C115/A21.15Flanged Ductile-Iron and Gray-Iron Pipe with Threaded Flanges

F. ANSI/AWWA C150/A21.50Thickness Design of Ductile-Iron Pipe

G. ANSI/AWWA C151/A21.51Ductile-Iron Pipe, Centrifugally Cast in Metal Molds or Sand-Lined Molds, for Water or Other Liquids

H. ANSI/AWWA C153/A21.53Ductile-Iron Compact Fittings, 3 in. Through 12 in. for Water and Other Liquids

I. AWWA C600 Installation of Ductile Iron Water Mains and Their Appurtenances

J. ASTM C 150 Specification for Portland Cement

K. ASTM B 1000 Standard Practices for Casting Preparation and Test Procedure of Porcelain Enamel-lined Pipe, Fittings, and Valves for Use in the Municipal Wastewater, Sewage, and Water Treatment Industry

1.3 SUBMITTALS

A. Shop Drawings: The Contractor shall submit shop drawings of pipe and fittings in accordance with the requirements in Section 01 33 00 – Submittal Procedures and the requirements of the referenced standards.

B. Certifications: The Contractor shall furnish a certified affidavit of compliance for all pipe and other products or materials furnished under this Section of the Specification, as specified in the referenced standards and the following supplemental requirements:

1. Physical and chemical properties.
2. Hydrostatic test reports.
3. AWWA- ANSI/NSF61 certification.

C. All expenses incurred in making samples for certification of tests shall be borne by the Contractor.

1.4 QUALITY ASSURANCE

A. Inspection: All pipe shall be subject to inspection at the place of manufacture in accordance with the provisions of the referenced standards, as supplemented by the requirements herein.

B. Tests: Except as modified herein, all materials used in the manufacture of the pipe shall be tested in accordance with the requirements of the Section 40 80 01 – Process Piping Testing, and the referenced standards as applicable.

C. The Contractor shall perform said material tests at no additional cost to the Owner. The Engineer shall have the right to witness all testing conducted by the Contractor; provided, that the Contractor’s schedule is not delayed for the convenience of the Engineer.

D. In addition to those tests specifically required, the Engineer may request additional samples of any material including lining and coating samples for testing by the Owner. The additional samples shall be furnished at no additional cost to the Owner.

PART 2 PRODUCTS

2.1 GENERAL

A. The pipe shall be of the diameter shown, shall be furnished complete with rubber gaskets as indicated in the Contract Documents, and all specials and fittings shall be provided as required under the Contract Documents.

B. Pipe manufacturer shall submit certification that source manufacturing facility has been producing ductile iron pipe of specified diameters, dimensions, and standards for a period of not less than 10 years. Testing of pipe required by AWWA C151/A21.51 shall be conducted in testing and laboratory facilities located in the USA and operating under USA laws and regulations. Pipe shall be handled during manufacture and shipped without nesting (without insertion of one pipe inside another).

2.2 MATERIALS

A. Ductile Iron Pipe: Pipe materials shall conform to the requirements of ANSI/AWWA C151.

B. Cement: Cement for mortar lining shall conform to the requirements of ANSI/AWWA C104; provided, that cement for mortar lining shall be Type II or V. A fly ash or pozzolan shall not be used as a cement replacement.

C. Glass: ASTM B1000

D. Polyethylene Sleeve: Material for the polyethylene sleeve shall conform to the requirements of ANSI/AWWA C105.

2.3 DESIGN OF PIPE

A. General: The pipe furnished shall be ductile iron pipe, mortar-lined and polyethylene-wrapped, with rubber-gasketed joints as shown.

B. The pipe shall be designed, manufactured, tested, inspected, and marked according to applicable requirements previously stated and except as hereinafter modified, shall conform to ANSI/AWWA C151.

C. Pipe Dimensions: The pipe shall be of the diameter shown. The minimum wall thickness for each pipe size shall be as specified or shown.

D. Fitting Dimensions: The fittings shall be of the diameter shown.

E. Joint Design: Ductile iron pipe and fittings shall be furnished with mechanical joints, push-on joints, flanged joints, and restrained joints as required.

1. Mechanical and push-on joints shall conform to ANSI/AWWA C111/A21.11. 250 pounds per square inch (psi) minimum working pressure

2. Flanged joints: dimensions per AWWA C110/A21.10 flat face, ductile iron, threaded conforming to ANSI/AWWA C115/A21.15.

3. Grooved End: Rigid type radius cut conforming to AWWA C606, 250 psi minimum working pressure; Victaulic.

4. Restrained joints shall be "Flex-Ring" or "Lok-Ring" Restrained Joint by American Ductile Iron Pipe, "TR FLEX" Restrained Joint by U.S. Pipe, or equal.

F. For bell-and-spigot ends with rubber gaskets, the clearance between the bells and spigots shall be such that when combined with the gasket groove configuration and the gasket itself, will provide watertight joints under all operating conditions when properly installed. The Contractor shall require the pipe manufacturer to submit details complete with significant dimensions and tolerances and also to submit performance data indicating that the proposed joint has performed satisfactorily under similar conditions. In the absence of a history of field performance, the results of a test program shall be submitted.

G. Shop-applied interior linings and exterior coatings shall be held back from the ends of the pipe as shown or as otherwise acceptable to the Engineer.

2.4 SPECIALS AND FITTINGS

A. Fittings for ductile iron pipe shall conform to the requirements of ANSI/AWWA C153/A21.53 or ANSI/AWWA C110/A21.10 for diameters 3-inch through 48-inch and shall have a minimum pressure rating of 250 psi.

2.5 CEMENT-MORTAR LINING (PIPE TYPE CLDI)

A. Cement-Mortar Lining for Shop Application: Except as otherwise provided herein, interior surfaces of all ductile iron pipe, fittings, and specials shall be cleaned and lined in the shop with cement-mortar lining applied centrifugally in conformity with ANSI/AWWA C104. During the lining operation and thereafter, the pipe shall be maintained in a round condition by suitable bracing or strutting. The lining machines shall be of a type that has been used successfully for similar work. Every precaution shall be taken to prevent damage to the lining. If lining is damaged or found faulty at delivery site, the damaged or unsatisfactory portions shall be replaced with lining conforming to these Specifications.

B. The minimum lining thickness shall be double thickness as defined by AWWA C 602.

C. Protection of Pipe Lining/Interior: All shop-applied cement mortar lining shall be given a seal coat of asphaltic material in conformance with ANSI/AWWA C104.

2.6 GLASS LINING (PIPE TYPE GLDI)

A. General: Ductile iron and fittings shall be glass-lined where indicated. The glass lining shall be suitable for handling sewage, primary sludge, digested sludge, and scum. It shall be smooth, continuous, and suitable for prevention of grease and foam build-up. The glass lining shall be capable of withstanding thermal shock of 350 degrees Fahrenheit (F) (430 degrees to 80 degrees) without crazing, blistering, or spalling.

B. Criteria: The glass lining shall consist of a vitreous material to meet or exceed the following criteria:

1. Unaffected by scraping with a sharp knife, simulating the effects of rodding.

2. Unaffected by the continuous application of live steam from a steam generator, immediately followed by a cold-water quench.

3. Unaffected by an 8 percent sulfuric acid solution at 148 degrees F for a 10-minute period.

4. Minimum thickness: 10 mils by micro test.

5. Spark tested: Surface must be free of pinholes.

6. Hardness: 5-6 Mohs.

7. Density: 2.5-3.0 grams per cubic centimeter (g/cu cm), measured by ASTM D 792 - Test Method for Specific Gravity (Relative Density) and Density of Plastics by Displacement.

C. Application: Cast or ductile iron pipes and fittings shall be bored or machined smooth to remove voids or protrusions. All interior surfaces shall be grit blasted to white metal and lining shall be fused on to chemically clean metal at above 1400 degrees F. All welded flanges shall be factory-installed before lining. Screwed flanges or cast and ductile iron pipes shall be installed after lining. All pieces shall be sealed and tested prior to shipment. Finish shall be subject to the Engineer'S approval.

D. Manufacturers:

1. The Pfaudler Co, Inc., Rochester, New York;
2. A.O. Smith Corp., Florence, Kentucky;
3. Waterworks, Mfg. Co., Marysville, California.
4. Or equal

2.7 EXTERIOR COATING OF PIPE

A. Exterior Coating of Exposed Piping: The exterior surfaces of pipe which will be exposed to the atmosphere inside structures or above ground shall be thoroughly cleaned and then given a shop coat of rust-inhibitive primer. Field coating shall be in accordance with the requirements of Section 09 90 00 – Painting and Coating.

B. Exterior Coating of Buried Piping: The exterior coating shall be an asphaltic coating approximately 1-mil thick. In addition, a polyethylene sleeve shall be installed.

PART 3 EXECUTION

3.1 INSTALLATION OF PIPE

A. Handling and Storage: All pipe, fittings, etc., shall be carefully handled and protected against damage, impact shocks, and free fall. All pipe handling equipment shall be acceptable to the Engineer. Pipe shall not be placed directly on rough ground but shall be supported in a manner which will protect the pipe against injury whenever stored at the trench site or elsewhere. No pipe shall be installed where the lining or coating show defects that may be harmful as determined by the Engineer. Such damaged lining or coating shall be repaired, or a new undamaged pipe shall be furnished and installed.

B. All pipe damaged prior to Substantial Completion shall be repaired or replaced by the Contractor.

C. The Contractor shall inspect each pipe and fitting prior to installation to ensure that there are no damaged portions of the pipe.

D. Before placement of pipe in the trench, each pipe or fitting shall be thoroughly cleaned of any foreign substance, which may have collected thereon and shall be kept clean at all times thereafter. For this purpose, the openings of all pipes and fittings in the trench shall be closed during any interruption to the work.

E. Pipe Laying: The pipe shall be installed in accordance with ANSI/AWWA C600.

F. Pipe shall be laid directly on the bedding material. No blocking will be permitted, and the bedding shall be such that it forms a continuous, solid bearing for the full length of the pipe. Excavations shall be made as needed to facilitate removal of handling devices after the pipe is laid. Bell holes shall be formed at the ends of the pipe to prevent point loading at the bells or couplings. Excavation shall be made as needed outside the normal trench section at field joints to permit adequate access to the joints for field connection operations and for application of coating on field joints.

G. Where necessary to raise or lower the pipe due to unforeseen obstructions or other causes, the Engineer may change the alignment and/or the grades. Such change shall be made by the deflection of joints, by the use of bevel adapters, or by the use of additional fittings. However, in no case shall the deflection in the joint exceed the maximum deflection recommended by the pipe manufacturer. No joint shall be misfit any amount which will be detrimental to the strength and water tightness of the finished joint.

H. Except for short runs which may be permitted by the Engineer, pipes shall be laid uphill on grades exceeding 10 percent. Pipe which is laid on a downhill grade shall be blocked and held in place until sufficient support is furnished by the following pipe to prevent movement. All bends shall be properly installed as shown.

I. Cold Weather Protection: No pipe shall be installed upon a foundation into which frost has penetrated or at any time that there is a danger of the formation of ice or penetration of frost at the bottom of the excavation. No pipe shall be laid unless it can be established that the trench will be backfilled before the formation of ice and frost occurs.

J. Pipe and Specials Protection: The openings of all pipe and specials shall be protected with suitable bulkheads to prevent unauthorized access by persons, animals, water or any undesirable substance. At all times, means shall be provided to prevent the pipe from floating.

K. Pipe Cleanup: As pipe laying progresses, the Contractor shall keep the pipe interior free of all debris. The Contractor shall completely clean the interior of the pipe of all sand, dirt, mortar splatter, and any other debris following completion of pipe laying, pointing of joints and any necessary interior repairs prior to testing the completed pipeline.

L. Finish: The pipe shall have smooth dense interior surfaces and shall be free from fractures, excessive interior surface crazing, and roughness.

3.2 RUBBER GASKETED JOINTS

A. Rubber Gasketed Joints: Immediately before jointing pipe, the bell end of the pipe shall be thoroughly cleaned, and a clean rubber gasket lubricated with an approved vegetable-based lubricant shall be placed in the bell groove. The spigot end of the pipe shall be carefully cleaned and lubricated with a vegetable-based lubricant. The spigot end of the pipe section shall then be inserted into the bell of the previously laid joint and telescoped into its proper position. Tilting of the pipe to insert the spigot into the bell will not be permitted.

3.3 POLYETHYLENE SLEEVE COATING

A. All buried ductile iron pipe shall be polyethylene encased in accordance with the requirements of ANSI/AWWA C105/A21.5.

3.4 INSTALLATION OF PIPE APPURTENANCES

A. Protection of Appurtenances: Where pipe is encased in polyethylene sleeves, buried appurtenances shall also be encased in polyethylene.

B. Installation of Valves: All valves shall be handled in a manner to prevent any injury or damage to any part of the valve. All joints shall be thoroughly cleaned and prepared prior to installation. The Contractor shall adjust all stem packing and operate each valve prior to installation to insure proper operation.

C. All valves shall be installed so that the valve stems are plumb and, in the location, shown.

3.5 PIPELINE TESTING

A. All pipes shall be tested in accordance with Section 40 80 01 –Process Piping Testing.

END OF SECTION

SECTION 40 05 10.02 – STAINLESS STEEL PIPE AND FITTINGS

PART 1 GENERAL

1.1 SUMMARY

A. Scope: This section specifies stainless steel pipe and fittings.

B. Types of Service: Stainless steel piping for aeration service is included in this section.

1.2 REFERENCE STANDARDS

A. ANSI B16.9, Factory-Made Wrought Steel Butt Welding Fitting

B. ANSI B16.28, Wrought Steel Butt Welding Short Radius Elbows and Returns

C. ASTM A240, Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications

D. ASTM A778, Standard Specification for Welded, Unannealed Austenitic Stainless Steel Tubular Products

1.3 SUBMITTALS

A. Shop Drawings: The Contractor shall submit shop drawings of pipe and fittings in accordance with the requirements in Section 01 33 00 – Submittal Procedures and the requirements of the referenced standards.

B. Certifications: The Contractor shall furnish a certified affidavit of compliance for all pipe and other products or materials furnished under this Section of the Specifications, as specified in the referenced standards and the following supplemental requirements:

1. Physical and chemical properties.
2. Hydrostatic test reports.

C. All expenses incurred in making samples for certification of tests shall be borne by the Contractor.

1.4 QUALITY ASSURANCE

A. Inspection: All pipe shall be subject to inspection at the place of manufacture in accordance with the provisions of the referenced standards, as supplemented by the requirements herein.

B. Tests: Except as modified herein, all materials used in the manufacture of the pipe shall be tested in accordance with the requirements of the referenced standards as applicable.

C. The Contractor shall perform said material tests at no additional cost to the Owner. The Engineer shall have the right to witness all testing conducted by the Contractor; provided, that the Contractor's schedule is not delayed for the convenience of the Engineer.

D. In addition to those tests specifically required, the Engineer may request additional samples of any material including lining and coating samples for testing by the Owner. The additional samples shall be furnished at no additional cost to the Owner.

PART 2 PRODUCTS

2.1 GENERAL

A. Pipe materials, connections, and installation shall meet all of the requirements described within the pipe schedule located in the drawings.

2.2 MATERIALS

A. 2-1/2" and smaller: schedule 40S, ASTM A312/A312M, type 304 seamless, pickled and passivated

B. 3" through 6": schedule 10S, ASTM A312/A312M, type 304 seamless, pickled and passivated

C. 8" and larger: schedule 5S, ASTM A312/A312M, type 304 seamless, pickled and passivated

2.3 FITTINGS AND JOINTS

A. 1-1/2" and smaller: Threaded. Forged 1,000 CWP minimum, ASTM A182/A182M, grade F304 or cast Class 150, ASTM A351/A351m, Grad CF8/304

B. 2" and larger: Butt-welded or flanged.

1. Butt-welded: ASTM A403/A403M, Grade WP304L conforming to ASME B16.9 and MSS SP 43, annealed, pickled and passivated; fitting wall thickness to match adjoining pipe; long radius elbows, unless shown otherwise.

2. Flanged joints:

a. Forged Stainless Steel: ASTM A182/A182M, Grade F304L, ASME B16.5 Class 150 or Class 300, slip-on weld neck or raised face. Weld slip-on flanges inside and outside.

b. Cast Carbon Steel: ASTM A216/A216M Grade WCA, drilled, ASME B16.5 Class 150 or Class 300 Van Stone Type with stainless steel stub ends, ASTM A240/A240M Type 304L "as-welded grade", conforming to MSS SP 43, wall thickness same as pipe.

3. Blind Flanges, exposed to the atmosphere and not buried nor immersed in liquid, may be either stainless steel or Class 125 ductile iron or Class 150 carbon steel with gaskets as specified herein.

2.4 PIPE SUPPORT SYSTEMS.

A. 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 07 – Hangers and Supports for Process Piping.

PART 3 EXECUTION

3.1 PIPE CUTTING, THREADING, AND JOINTING

A. Pipe cutting, threading, and jointing shall conform to the requirements of ANSI B31.1. All pipe threads shall be lubricated with Teflon tape.

3.2 WELDING

A. General: Piping with wall thickness up to 11-gauge (0.120-inch) shall be welded with the tungsten inert gas (TIG) (gas tungsten arc welding (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), metal inert gas (MIG) (gas metal arc welding (GMAW)), or Metalic Arc (shielded metal arc welding (SMAW)) processes. Filler wire of extra low carbon (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 internal dimension (ID) and 3/32-inch on the outside dimension (OD) 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:

1. Field welding shall be minimized to the greatest extent possible by the use of couplings and prefabrication of pipe systems at the factory. Pipe butt welds may be performed at the job site, providing the butt welds are performed only with an inert gas shielded process and that other applicable specified welding requirements are rigidly adhered to.

2. 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.

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. Caulking 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 the 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.

3.3 MARKING, SHIPPING, AND STORAGE

A. All pipe fittings and fabrications shall be properly marked with type, gauge, 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.

3.4 FABRICATION/INSTALLATION REQUIREMENTS

A. 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.

3.5 COATINGS

A. 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.

3.6 TESTING

A. All pipe testing shall be completed in accordance to Section 40 80 01 Process Piping Testing.

END OF SECTION

SECTION 40 05 10.03 – PVC PIPE AND FITTINGS

PART 1 GENERAL

1.1 SUMMARY

A. The Contractor shall furnish and install corrosion resistant polyvinyl chloride (PVC) pressure pipe fittings and special items in accordance with the requirements of the Contract Documents.

B. Pipe Type: PVC, SCH 80.

1.2 REFERENCE STANDARDS

A. ANSI/AWWA C605 Underground Installation of PVC and PVCO Pressure Pipe and Fittings

B. ASTM D1784 Standard Specification for Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds

C. ASTM D1785 Standard Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe

D. ASTM D1598 Standard Test Method for Time-to-Failure of Plastic Pipe Under Constant Internal Pressure

E. ASTM D2672 Standard Specification for Joints for IPS PVC Pipe Using Solvent Cement

F. ASTM D2241 Standard Specification of Poly (Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series)

G. ASTM F477 Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe

H. ANSI/AWWA C219 Bolted, Sleeve-Type Couplings for Plain-End Pipe

I. AWWA M23 Manual of Supply Practices - PVC Pipe—Design and Installation, Latest Edition

1.3 SUBMITTALS

A. Shop Drawings: The Contractor shall submit shop drawings of pipe and fittings in accordance with the requirements in Section 01 33 00 – Submittal Procedures and the requirements of the referenced standards.

B. Certifications: The Contractor shall furnish a certified affidavit of compliance for all pipe and other products or materials furnished under this Section of the Specifications, as specified in the referenced standards and the following supplemental requirements:

1. Physical and chemical properties.
2. Hydrostatic test reports.
3. AWWA- ANSI certification.

C. All expenses incurred in making samples for certification of tests shall be borne by the Contractor.

1.4 QUALITY ASSURANCE

A. Inspection: All pipe shall be subject to inspection at the place of manufacture in accordance with the provisions of the referenced standards, as supplemented by the requirements herein.

B. Tests: Except as modified herein, all materials used in the manufacture of the pipe shall be tested in accordance with the requirements of the referenced standards as applicable.

C. The Contractor shall perform said material tests at no additional cost to the Owner. The Engineer shall have the right to witness all testing conducted by the Contractor; provided, that the Contractor's schedule is not delayed for the convenience of the Engineer.

D. In addition to those tests specifically required, the Engineer may request additional samples of any material including lining and coating samples for testing by the Owner. The additional samples shall be furnished at no additional cost to the Owner.

E. All references to standards shall be the latest versions of those standards.

PART 2 PRODUCTS

2.1 GENERAL

A. PVC piping materials shall meet the specifications of this Section and of the appropriate Standards. In the case of conflict, the more stringent specifications shall apply.

B. Unless otherwise specified herein or shown on the plans, the minimum pressure rating of all pipes specified herein shall be 1.5 times the operating pressure or 150 pounds per square inch (psi) minimum.

C. Laying Lengths: Maximum pipe laying lengths shall be 20 feet with shorter lengths provided as required by the Drawings.

2.2 PIPE DESIGN CRITERIA

A. General: SCH 80 PVC pipe shall be designed in accordance with the requirements of ASTM Standard D1784 as applicable and as modified in this Section.

B. Pipe Wall Thickness for Internal Pressure: The pipe shall be designed with a net thickness to withstand the design pressure in accordance with the hoop stress formula.

C. Pipe shall be manufactured in strict compliance with ASTM D1785 for physical dimensions and tolerances.

2.3 MATERIALS

A. SCH 80 PVC Pipe: Pipe materials shall conform to the requirements of ASTM D1784, Cell Classification 12454 = PVC Type I Grade I = PVC1120.

B. Pipe manufactured in compliance with this Section, shall also meet or exceed the test requirements for materials, workmanship, burst pressure, flattening, and extrusion quality defined in ASTM D1785.

C. All belled-end pipe shall have tapered sockets to create an interference-type fit, which meet or exceed the dimensional requirements and the minimum socket length for pressure-type sockets as defined in ASTM D2672.

D. Solvent Cement: Socket type joints shall be made employing solvent cement that meets or exceeds the requirements of ASTM D2564 and primer that meets or exceeds requirements of ASTM F656, chemically resistant to the fluid service, and as recommended by pipe and fitting manufacturer. Except solvent weld cement for PVC pipe joints in sodium hypochlorite service shall be free of silica filler and shall be certified by the manufacturer to be suitable for that service, IPS Weld-On 724 or approved equal. Certification shall be submitted

2.4 FITTINGS

A. Schedule to Match Pipe Above: ASTM D2466 and ASTM D2467 for socket weld type and Schedule 80 ASTM D2464 for threaded type. Fittings shall be manufactured with titanium dioxide for ultraviolet protection.

2.5 JOINTS

A. Solvent socket weld except where connection to threaded valves and equipment may require future disassembly.

B. Flanges: One-piece, molded hub type PVC flat face flange in accordance with Fittings above, ASME B16.1, Class 125 drilling

C. Bolting:

1. Flat Face Mating Flange and In Corrosive Areas: ASTM A193/A193M, Type 316 stainless steel Grade B8M hex head bolts, ASTM A194/A194M Grade 8M hex head nuts and ASTM F436 Type 3 alloy washers at nuts and bolt heads. Achieve 40 percent to 60 percent of bolt minimum yield stress.

2. Raised Face Mating Flange: Carbon steel ASTM A307 Grade B square head bolts, ASTM A563 Grade A heavy hex head nuts and ASTM F436 hardened steel washers at nuts and bolt heads. Achieve 40 percent to 60 percent of bolt minimum yield stress.

D. Gaskets:

1. Flat Face Mating Flange: Full faced 1/8-inch-thick ethylene propylene (EPR) rubber.

2. Raised Face Mating Flange: Flat ring 1/8-inch ethylene propylene (EPR) rubber with filler gasket between optical density (OD) of raised face and flange OD to protect the flange from bolting moment.

PART 3 EXECUTION

3.1 INSTALLATION OF PIPE

A. Handling and Storage: All pipe, fittings, etc., shall be carefully handled and protected against damage, impact shocks, and free fall. All pipe handling equipment shall be acceptable to the Engineer. Pipe shall not be placed directly on rough ground but shall be supported in a manner which will protect the pipe against injury whenever stored at the trench site or elsewhere. No pipe shall be installed where the lining or coating show defects that may be harmful as determined by the Engineer. Such damaged lining or coating shall be repaired, or a new undamaged pipe shall be furnished and installed.

B. All pipe damaged prior to Substantial Completion shall be repaired or replaced by the Contractor.

C. The Contractor shall inspect each pipe and fitting prior to installation to ensure that there are no damaged portions of the pipe.

D. PVC pressure pipe may be deflected both horizontally and vertically at the joints after assembly. Deflection by bending of the pipe rather than at the joints is not allowed. The maximum pipe deflection shall not exceed one half of the manufacturer’s stated joint deflection allowance.

3.2 INSTALLATION OF PIPE APPURTENANCES

A. Installation of Valves: All valves shall be handled in a manner to prevent any injury or damage to any part of the valve. All joints shall be thoroughly cleaned and prepared prior to installation. The Contractor shall adjust all stem packing and operate each valve prior to installation to insure proper operation.

B. All valves shall be installed so that the valve stems are plumb and, in the location, shown.

3.3 PIPELINE TESTING

A. All pipes shall be tested in accordance with Section 40 80 01 – Process Piping Testing.

B. Do not pneumatically test PVC piping at any pressure.

END OF SECTION

SECTION 40 05 52 – PROCESS VALVES

PART 1 GENERAL

1.1 SUMMARY

A. The Contractor shall provide all valves, actuators, and appurtenances, complete and operable, in accordance with the Contract Documents.

B. The provisions of this Section shall apply to all valves and valve actuators except where otherwise indicated. Valves and actuators in particular locations may require a combination of units, sensors, limit switches, and controls indicated in other Sections of the Specifications.

C. Unit Responsibility: A single manufacturer shall be made responsible for coordination of design, assembly, testing, and furnishing of each valve; however, the Contractor shall be responsible to the Owner for compliance with the requirements of each valve section. Unless indicated otherwise, the responsible manufacturer shall be the Manufacturer of the valve.

D. Single Manufacturer: Where two or more valves of the same type or size are required, the valves shall be furnished by the same Manufacturer.

1.2 REFERENCE STANDARDS

A. American National Standards Institute (ANSI): Z21.15, Manually Operated Gas Valves for Appliances, Appliance Connector Valves and Hose End Valves.

B. American Society of Mechanical Engineers (ASME):

1. B16.1, Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250.

2. B16.44, Manually Operated Metallic Gas Valves for Use in Above Ground Piping Systems up to 5 psi.

C. American Society of Sanitary Engineers (ASSE): 1011, Performance Requirements for Hose Connection Vacuum Breakers.

D. American Water Works Association (AWWA):

1. C500, Metal-Seated Gate Valves for Water Supply Service.

2. C504, Rubber-Seated Butterfly Valves, 3 In. (75 mm) Through 72 In. (1,800 mm).

3. C508, Swing-Check Valves for Waterworks Service, 2-In. Through 24-In. (50-mm Through 600-mm) NPS.

4. C509, Resilient-Seated Gate Valves for Water Supply Service.

5. C510, Double Check Valve Backflow Prevention Assembly.

6. C511, Reduced-Pressure Principle Backflow Prevention Assembly.

7. C512, Air-Release, Air/Vacuum, and Combination Air Valves for Waterworks Service.

8. C515, Reduced-Wall, Resilient-Seated Gate Valves for Water Supply Service.

9. C550, Protective Interior Coatings for Valves and Hydrants.

10. C800, Underground Service Line Valves and Fittings.

1.3 SUBMITTAL

A. General: Submittals shall be furnished in accordance with Section 01 33 00 –Submittal Procedures.

B. Shop Drawings: Shop drawings shall contain the following information:

1. Valve name, size, flow coefficient of the valve (Cv) factor, pressure rating, identification number (if any), and specification section number.

2. Complete information on valve actuator, including size, Manufacturer, model number, limit switches, and mounting.

3. Cavitation limits for all control valves.

4. Assembly drawings showing part nomenclature, materials, dimensions, weights, and relationships of valve handles, handwheels, position indicators, limit switches, integral control systems, needle valves, and control systems.

5. Complete wiring diagrams and control system schematics.

6. Valve Labeling: A schedule of valves to be labeled, indicating in each case the valve location and the proposed wording for the label.

C. Owner's Manual: The Owner's Manual shall contain the required information for each valve.

D. Spare Parts List: A Spare Parts List shall contain the required information for each valve assembly, where indicated.

E. Factory Test Data: Where indicated, signed, dated, and certified factory test data for each valve requiring certification shall be submitted before shipment of the valve. The data shall also include certification of quality and test results for factory-applied coatings.

PART 2 PRODUCTS

2.1 PRODUCTS - GENERAL

A. General: All valves and gates shall be new and of current manufacture. All shut-off valves 6 inches and larger shall have actuators with position indicators. Buried valves shall be provided with valve boxes and covers containing position indicators and valve extensions. Manual shut-off valves mounted higher than 6 feet above working level shall be provided with chain actuators.

B. Valve Actuators: Unless otherwise indicated, valve actuators shall be in accordance with Section 40 05 57 – Actuators for Process Valves and Gates.

C. Protective Coating: The exterior surfaces of all valves and the wet interior surfaces of all ferrous valves of sizes 4 inches and larger shall be coated in accordance with Section 09 90 00 – Painting and Coating. Finish color for valves shall be same as coating system and finish color of connected piping. The valve Manufacturer shall certify in writing that the required coating has been applied and tested in the manufacturing plant prior to shipment, in accordance with these Specifications. Flange faces of valves shall not be epoxy coated.

D. Valve Labeling: Except when such requirement is waived by the Engineer in writing, a label shall be provided on all shut-off valves and control valves except for hose bibbs and chlorine cylinder valves. The label shall be of 1/16-inch plastic or stainless steel, minimum 2 inches by 4 inches in size, and shall by permanently attached to the valve or on the wall adjacent to the valve as directed by the Engineer.

E. Valve Testing: As a minimum, unless otherwise indicated, each valve body 4 inches and larger shall be tested hydrostatically to 1.5 times its rated 100 degrees Fahrenheit (F) design water-working pressure, for a period of 5 minutes, without showing any leaks or loss of pressure. In addition, each valve 4 inches and larger shall undergo a functional test to demonstrate satisfactory operation throughout its operating cycle, and a closure test at rated 100 degrees F water-working pressure for a period of 5 minutes to demonstrate tight shut-off. Stem seal leakage shall not be a cause for rejection. All valves 3 inches and smaller shall undergo the Manufacturer's standard test.

F. Certification: Prior to shipment, the Contractor shall submit for all valves over 12 inches in size, certified, notarized copies of the hydrostatic factory tests, showing compliance with the applicable standards of AWWA, ANSI, and ASTM International (ASTM).

G. Valve Marking: All valve bodies shall be permanently marked in accordance with Manufacturers Standardization Society (MSS) SP25 - Standard Marking Systems for Valves, Fittings, Flanges, and Unions.

H. Nuts and Bolts: All nuts and bolts on valve flanges and supports shall be in accordance with Manufacturer's standards.

2.2 VALVE ACCESSORIES

A. All valves shall be furnished complete with the accessories required to provide a functional system.

B. Buried and Submerged Valves:

1. Provide seals on shafts and gaskets on valve and actuator covers to prevent water entry.

2. Provide totally enclosed actuator mounting brackets with gasket seals.

C. Valve Boxes

1. Provide for buried valves.
2. Three-piece screw type cast iron box and cover.
3. Valve box diameter 5-1/4-inch, length as required for installation.
4. Provide extension stems, complete with operating nuts, as required for installation.

D. Floor Boxes:

1. Provide for valves as shown on Drawings.

2. Cast iron box and cover.

3. Provide valves with extension stems, complete with operating nuts, as required to locate top of operating nuts 2 inches below top of floor box cover.

E. Extension Stems for Submerged Valves:

1. Provide for valves as shown on Drawings.

2. Provide with intermediate stem guides with maximum spacing not exceeding 10 feet or L/R not exceeding 200.

3. Type 304 stainless steel.

2.3 SPARE PARTS

A. Where indicated, the Contractor shall furnish the required spare parts suitably packaged and labeled with the valve name, location, and identification number. The Contractor shall also furnish the name, address, and telephone number of the nearest distributor for the spare parts of each valve. All spare parts are intended for use by the Owner, only, after expiration of the guarantee period.

2.4 VALVES

A. Butterfly Valves (V-100+ Series)

1. General:

a. In full compliance with AWWA C504 and following requirements:

1) Suitable for throttling operations and infrequent operation after periods of inactivity.

2) Elastomer seats which are bonded or vulcanized to the body shall have adhesive integrity of bond between seat and body assured by testing, with minimum 75-pound pull in accordance with ASTM D429, Method B.

3) Bubble-tight with rated pressure applied from either side. Test valves with pressure applied in both directions.

4) No travel stops for disc on interior of body.

5) Self-adjusting V-type or O-ring shaft seals.

6) Isolate metal-to-metal thrust bearing surfaces from flow stream.

7) Provide traveling nut or worm gear actuator with handwheel. Valve actuators to meet the requirements of AWWA C504.

8) Buried service operators shall withstand 450 foot-pounds of input torque at fully open and fully closed positions.

9) Provide linings and coatings per AWWA, unless otherwise indicated on Drawings or specified herein.

10) Valves to be in full compliance with NSF/ANSI 61.

b. Non-AWWA butterfly valves to meet the following actuator requirements:

1) For above ground installations, provide handle and notch plate for valves 6 inches and smaller and heavy-duty, totally enclosed gearbox type operators

with handwheel, position indicator and travel stops for valves 8 inches and larger, unless otherwise indicated on Drawings or specified herein.

2. Type V-100 Butterfly Valve, Water Works Service

    a. Size: 3 inches to 72 inches

    b. AWWA C504, Class 150B

    c. Short body type, flanged ends

    d. Cast-iron body, cast or ductile iron disc, Type 304 stainless steel shafts, rubber seat, and stainless steel seating surface

    e. Provide epoxy lining in compliance with AWWA C550.

    f. Manufacturers and Products:

        1) Pratt; Model 2FII or Triton XR-70
        2) DeZurik; AWWA Valve

3. Type V-102 Butterfly Valve, General Service

    a. Size: 3 inches to 20 inches

    b. AWWA C504, Class 150B

    c. Wafer style type

    d. Buna-N rubber seat

    e. Manufacturers and Products:

        1) Pratt Monoflange Mark II

4. Type V-103 Butterfly Valve, Low Pressure Process Air Service Isolation

    a. Size: 24 inches to 48 inches

    b. Resilient Seated

    c. Flanged style cast-iron body, aluminum bronze discs, Type 304 stainless steel one-piece stem, self-lubricating bronze sleeve type bearing, ethylene propylene diene methylene (EPDM) replaceable resilient seat suitable for operating temperatures up to 250 degrees F, 150 pounds per square inch (psi) working pressure, rating, bubble-tight at 50 psi differential pressure, externally adjustable bronze packing gland with Buna-N packing, valve body to fit between ASME B16.1 Class 125/150 flanges.

d. Manufacturers and Products:

1) Bray Controls; Series 35.
2) Tyco/Keystone; Figure 106.

5. Type V-104 Butterfly Valve, Low Pressure Process Air Service Modulating

a. Size: 2 inches to 36 inches

b. High Performance

c. ASME B16.1 Class 150, high performance type, Type 316 stainless steel body, Type 316 stainless steel single or double offset disc, Type 316 stainless steel shaft and taper pins, polytetrafluoroethylene (PTFE) seat, PTFE stem packing, stainless steel with reinforced Tetrafluoroethylene (RTFE) thrust washer.

d. Manufacturers and Products:

1) Tyco/Keystone; K-Lok Series
2) DeZurik; BHP Series

B. Ball Valves (V-200+ Series)

1. Type V-200 Metal Ball Valves, General Water and Air Service

a. Size: 4 inches and smaller

b. Body: Ball valves up to 1-1/2-inch (included) in size shall have bronze or carbon steel 2- or 3-piece bodies with screwed ends for a pressure rating of not less than 600 psi water, oil, gas (WOG). Valves 2-inch to 4-inch in size shall have bronze or carbon steel 2- or 3-piece bodies with flanged ends for a pressure rating of ANSI 125 psi or 150 psi unless otherwise indicated.

c. Balls: The balls shall be solid chrome plated brass or bronze, or stainless steel, with standard port (single reduction) or full port openings.

d. Stems: The valve stems shall be of the blow-out proof design, of bronze, stainless steel, or other acceptable construction, with reinforced Teflon seal.

e. Seats: The valve seats shall be of Teflon or Buna-N, for bi-directional service and easy replacement.

f. Manufacturers:

1) Conbraco Industries, Inc. (Apollo)
2) ITT Engineered Valves
3) Neles-Jamesbury, Inc.
4) Nibco
5) Watts Regulator
6) Worcester Controls
7) Flow-Tek

2. Type V-201 Plastic Ball Valves, Chemical Service

a. Size: 4 inches and smaller

b. Plastic ball valves for corrosive fluids shall be made of polyvinyl chloride (PVC), chlorinated polyvinyl chloride (CPVC), polypropylene (PP), or polyvinylidene fluoride (PVDF), as recommended by the Manufacturer for the specific application.

c. Plastic ball valves with a vented ball shall be installed so that the vent is directed back upstream

d. Construction

1) Plastic ball valves shall have union ends or flanged ends to mate with ANSI B 16.5, class 150 flanges, for easy removal. The balls shall have full size ports and Teflon seats. Body seals, union O-ring seals, and stem seals shall be in accordance with the corrosion resistance requirements of respective valve manufacturer. External (without entering into the wetted area) seat packing adjustment is preferred. Metal reinforced stems to prevent accidental breakage are preferred. The valves shall be suitable for a maximum working non-shock pressure of 150 psi at 73 degrees F for PVC and CPVC, with decreasing ratings for higher temperatures and other plastics.

2) Ball valves for chemical solutions that produce off-gas, such as sodium hypochlorite, shall be provided with vented balls with pressure relief hole drilled on low pressure side by the ball valve manufacturer.

e. Manufacturers:

1) ASAHI-America
2) Nibco
3) George Fischer, Inc.
4) Plast-O-Matic Valves, Inc.
5) Spears Mfg Co.

C. Plug Valves (V-300+ Series)

1. Type V-300 Plug Valves, General Water and Sludge Service

    a. Size: All

    b. Flanged, non-lubricated, resilient seated eccentric type.

    c. Drip-tight shutoff up to full pressure rating of valve, with pressure in either direction.

    d. Pressure rating:

        1) Valves 12-inch and smaller: 175 psi gauge (psig)
        2) Valves 14-inch and larger: 150 psig

    e. Cast iron body, ASTM A 126, Grade B.

    f. Buna-V packing or O-ring seals.

    g. Nickel seats.

    h. Balanced plug coated with Hycar.

    i. End Style:

        1) Non-buried service: Flanged ends, 150-pound ANSI standard.
        2) Buried service: Mechanical joint.

    j. Bearings:

        1) Valves 20-inch and smaller: Stainless steel.
        2) Valves 24-inch and larger: Bronze or stainless steel.

    k. Manufacturers:

        1) DeZurik Series 100, Figure 118
        2) Milliken, Millcentric Series 600
        3) Pratt, Ballcentric
        4) Val-Matic, Series 5000

2. Type V-305 3-way Plug Valves, General Water and Sludge Service

    a. Concentric, non-lubricated with resilient faced plug capable of 360-degree rotation to shut off any of the three ports.

    b. Port areas are 100 percent of pipe area.

c. Drip-tight shutoff up to full pressure rating of valve, with pressure in any direction.

d. Pressure Rating 175 psi.

e. Body of ASTM A536 Ductile Iron

f. Fusion bonded epoxy coating interior/exterior

g. Flanges per ANSI B16.1, Class 125

h. Radial bearings shall be self-lubricating type 316 SST

i. Externally adjustable 2 way thrust bearing shall be bronze

j. Shaft seals shall be "V" type packing in a fixed gland with an adjustable follower

k. Manufacturers

1) DeZurik
2) Milliken
3) Val-Matic

D. Check Valves (V-400+ Series)

1. Type V-400 Check Valves, General Service

a. Size: 2 inches and smaller

b. All bronze

c. Threaded cap, threaded ends

d. Swing type

e. Replaceable Teflon disc and bronze disc holder

f. Rated 125-pound SWP, 200-pound WOG

g. Manufacturers:

1) Walworth
2) Milwaukee

2. Type V-401 Check Valve, General Service

a. Size: 2-1/2 inches to 12 inches

b. Cast-iron body

c. Flanged end

d. Bronze mounted swing type

e. Solid bronze or cast-iron disc

f. Bronze seat ring

g. Rated 125-pound SWG, 200-pound WOG

h. Manufacturers:

   1) Stockham
   2) Crane Co.

3. Type V-405 Cushioned Swing Check Valve, General Service

   a. Size: 2 inches to 48 inches

   b. Swing check valves are of self-contained, free-swinging disc style, allowing a clear waterway. Valve disc swings freely open and is keyed to valve hinge pin without the use of pins.

   c. Cast iron body and cover

   d. Ductile iron hinge and disc

   e. Buna-N, stainless steel, or bronze disc seating surface

   f. Bronze or stainless steel seat rings

   g. Two-component epoxy internal and external coatings

   h. Manufacturer or equal:

      1) APCO
      2) Val-Matic

4. Type V-406 PVC Ball Check Valve, Chemical Service

   a. Size: 4 inches and smaller

   b. ASTM D1784, Type I, Grade 1 PVC body

   c. Single or dual union socket weld ends

d. Rated 150 psi at 73 degrees F, 110 psi at 140 degrees F

e. Viton seat and seal

f. Manufacturers:

1) Nibco; Chemtrol Tru Union
2) ASAHI/America
3) Spears; True Union

5. Type V-407 CPVC Ball Check Valve, Chemical Service

a. Size: 4 inches and smaller

b. ASTM D1784 Cell Class 23477B CPVC body

c. Single or dual union socket weld ends

d. Rated 150 psi at 73 degrees F, 110 psi at 140 degrees F

e. Viton seat and seal

f. Manufacturers:

1) Nibco; Chemtrol Tru Union
2) ASAHI/America
3) Spears; True Union

6. Type V-408 Double Check Valve Backflow Prevention Assembly

a. Size: 3/4-inch to 10 inches

b. Two resilient seated check valves, two nonrising stem resilient-seated isolation valves, test cocks, in accordance with AWWA C510

c. Rated 175 psi maximum working pressure

d. Meets requirements of University of Southern California (USC) Foundation for Cross-Connection Control and Hydraulic Research

e. Manufacturers:

1) FEBCO
2) Danfoss Flomatic
3) Watts Regulator Company

7. Type V-409 Reduced Pressure Principle Backflow Prevention Assembly

a. Size: 3/4-inch to 10 inches

b. Backflow preventers shall work on the reduced pressure principle. They shall consist of two spring-loaded check valves, automatic differential pressure relief valve, drain valves, and shut-off valves. The body material shall be bronze or cast iron for a working pressure of not less than 150 psi, with bronze or stainless steel trim. Drain lines with air gaps shall be provided. The backflow preventer valves shall be in accordance with AWWA C511 standard.

c. Manufacturers:

1) Cla-Val Company
2) FEBCO
3) Hersey Products, Inc.
4) Watts Regulator Company
5) Wilkins Regulator Company (Division of Zurn Industries)

8. Type V-410 Check Valve, Duckbill Type

a. Size: 1-inch to 48 inches

b. Elastomer type flanged or slip-on as shown on Drawings.

c. Round entry area to match pipe, contoured duckbilled shaped exit, flat bottom and off-set bill design, curved bill for 18 inches and larger, valve open with approximately 2 inches of line pressure and return to close position under zero flow condition

d. Rated for 50 psi minimum operating pressure

e. Flanges steel backing flange type, drilled to ASME B16.1, Class 125, plain-end valve attached with two Type 316 stainless steel adjustable bands

f. Elastomer nylon-reinforced neoprene or Buna-N

g. Manufacturer:

1) Red Valve Co.; Tideflex Check Valve.

E. Gate Valves (V-500+ Series)

1. Type-500 Gate Valves

a. The resilient seat gate valves shall fully comply with the latest revision of AWWA C509 and shall also be Underwriters Laboratories (UL) listed and Factory Mutual (FM) approved.

b. The gate valve shall have a 250 psig working pressure.

c. The valve type shall be non-rising stem (NRS) or outside screw and yoke (OS&Y) as specified.

d. The valve shall have an arrow cast on the operating nut or handwheel showing opening direction. The direction of opening shall be as specified.

e. The NRS valves shall be provided with a 2-inch square operating nut and OS&Y valves shall be provided with a handwheel. The bolt that attaches the operating nut to the stem shall be recessed into the operating nut so as not to interfere with valve wrench operation.

f. The valves shall have bolts and nuts for the stuffing box and bonnet with one of the following compositions:

   1) Steel, ASTM A-307, Grade B zinc plated.
   2) Type 304 stainless steel.
   3) Type 316 stainless steel

g. The gate valve stem shall be made of bronze ASTM B-132 alloy C67600 bar stock material. The stem shall have at least one "anti-friction" thrust washer above and below the stem collar to reduce operating torque. The design of the NRS valve stem shall be such that if excessive input torque is applied, stem failure shall occur above the stuffing box at such a point as to enable the operation of the valve with a pipe wrench or other readily available tool. The stem material shall provide a minimum 70,000 psi tensile strength with 15 percent elongation and yield strength of 30,000 psi. Valves with cast stems or two-piece stem collars are not acceptable.

h. The NRS valves shall have a stuffing box that is O-ring sealed. Two O-rings shall be placed above and one O-ring below the stem thrust collar. The thrust collar shall be factory lubricated. The thrust collar and its lubrication shall be isolated by the O-rings from the waterway and from outside contamination providing permanent lubrication for long term ease of operation. Valves without a stuffing box are unacceptable. Valves without at least three stem O-rings are also unacceptable.

i. The gate valve body, bonnet, stuffing box, and disc shall be composed of ASTM A-126 Class B grey iron or ASTM A395 or A536 ductile iron. The body and bonnet shall also adhere to the minimum wall thickness as set forth in Table 2, section 4.3.1 of AWWA C509.

j. The valve disc and guide lugs must be fully (100 percent) encapsulated in SBR ASTM D2000 rubber material. The peel strength shall not be less than 75 pounds per inch. Guide caps of an acetal bearing material shall be placed over solid guide lugs to prevent abrasion and to reduce the operating torque.

k. The valves shall have all internal and external ferrous surfaces coated with a fusion bonded thermosetting powder epoxy coating of 10 mils nominal thickness. The coating shall conform to AWWA C550.

l. The tapping valves shall have an inlet flange conforming to ANSI B16.1 Class 125 for attachment to a tapping sleeve or cross. In addition, the valve inlet flange shall have a machined projection or raised face complying with MSS SP-60 for accurate alignment to the mating recess in the tapping sleeve flange. The seat opening of the tapping valves shall be at least 0.30 inches larger than the nominal pipe size to permit full diameter cuts.

m. The valves shall be warranted by the manufacturer against defects in materials or workmanship for a period of 10 years from the date of manufacture. The manufacturing facility for the valves must have current ISO certification.

n. Manufacturers:

1) Mueller A2360 series
2) American Flow Control 2500 Series
3) Or approved equal

F. Needle Valves (V-600+ Series)

1. Type V-600 Metal Needle Valve, Water Service

a. Size: 3/4 inches and smaller

b. PVC

c. Threaded bonnet, packed gland, rising stem, bronze body, and stem

d. Class 200 rated 200 psi Steam Working Pressure (SWP)/400 psi Cold Working Pressure (CWP), complies with MSS SP-80

e. Manufacturers:

1) Crane Cat
2) Stockham

2. Type V-601 Plastic Needle Valve, Gas and Chemical Service

a. Size: 1-inch and smaller

b. Injection molded in PVC, CPVC, Polypropylene, or high purity polyvinylidene fluoride (HP PVDF) with PTFE seals

c. Globe pattern and angle pattern

d. Threaded ends or solvent socket, compression tube assessor fittings

e. Rated 200 psi minimum

f. Manufacturers:

1) ASAHI-America
2) Marquest Scientific

G. Globe Valves (V-700+ Series)

1. Type V-700 Globe Valve, Water Service

a. Size: 3 inches and smaller

b. All-bronze

c. National pipe thread (NPT) threaded ends, union bonnet, packed gland, inside screw, rising stem, tetrafluoroethylene (TFE) disc

d. Up to Class 200 rated 200 psi SWP/400 psi CWP, complies with MSS SP-80

e. Manufacturers:

1) Stockham
2) Crane Co.

2. Type V-701 Globe Valve, General Service

a. Size: 2 inches to 10 inches

b. Iron body, bronze mounted

c. Flanged ends, bronze seat, OS&Y, bolted bonnet, Class 125 rated 125 psi SWP/200 psi CWP, complies with MSS SP-85 Type 1.

d. Manufacturers:

1) Stockham
2) Crane Co.

3. Type V-704 Hose Valve

a. Size: 1-inch to 3 inches

b. Angle Pattern or Globe Style

c. All-bronze, NPT threaded ends, inside screw-type rising stem, TFE disc, complies with MSS SP-80, rated 300 WOG.

d. Manufacturers:

1) Stockham
2) Crane Co.
3) Nibco

H. Regulating and Release Valves (V-800+ Series)

1. Type V-800 Pressure-Reducing Valve, Water Service

a. Size: 2-1/2 inches and smaller

b. Direct diaphragm operated, spring controlled, bronze body, NPT threaded ends, 200-psig rated minimum.

c. Size/Rating: As shown in Valve Schedule.

d. Manufacturers and Products:

1) Fisher
2) Watts

2. Type V-810 PVC Pressure Relief, By-Pass Relief, Back-Pressure Regulator, Back-Pressure, Anti-Siphon Valve, Chemical Service

a. Size: 1/2-inch to 2 inches

b. Direct acting diaphragm, spring controlled, in-line pattern, NPT threaded inlet and outlet, 150 psi design pressure.

c. PVC body, Teflon or Viton diaphragm, PVC or Teflon piston, high-density polyethylene or stainless steel adjusting bolt and locknut, stainless steel or coated steel spring, stainless steel fasteners.

d. Designed to open when upstream pressure reaches setpoint; set pressure adjustable from 10 psi to 100 psi, minimum.

e. Manufacturers:

1) Plast-O-Matic; Series RVD

2) Griffco; Series BPV
3) Primary Fluid Systems; TOP Valve

3. Type V-820 Wastewater Air and Vacuum Valves

   a. Air and vacuum valves shall be capable of venting large quantities of air while pipelines are being filled and allowing air to re-enter while pipelines are being drained. Valves shall be suitable for wastewater with high solids content.

   b. Size: 16 inches and small

   c. Flanged or screwed ends to match piping. Bodies shall be of high-strength cast iron. The float, seat, and all moving parts shall be constructed of Type 316 stainless steel. Seat washers and gaskets shall be of a material insuring water tightness with a minimum of maintenance. Valves shall be designed for minimum 150 psi water-working pressure, unless otherwise shown. Isolation valve shall be provided.

   d. Manufacturers:

      1) APCO (Valve and Primer Corporation)
      2) Crispin (Multiplex Manufacturing Company)
      3) Golden-Anderson Valve Division (GA Industries, Inc.)
      4) Val-Matic (Valve and Manufacturing Corporation)

4. Type V-821 Wastewater Air-Release Valves

   a. Air-release valves shall vent accumulating air while system is in service and under pressure and be of the size shown and shall meet the same general requirements as specified for air and vacuum valves except that the vacuum feature will not be required. Valves shall be suitable for wastewater with high solids content.

   b. Minimum water-working pressure of 150 psi, unless otherwise shown. Isolation valve shall be provided.

   c. Manufacturers:

      1) APCO (Valve and Primer Corporation)
      2) Crispin (Multiplex Manufacturing Company)
      3) Golden-Anderson Valve Division (GA Industries, Inc.)
      4) Val-Matic (Valve and Manufacturing Corporation)

5. Type V-822 Wastewater Combination Air Valves

a. Combination air valves shall combine the characteristics of air and vacuum valves and air release valves by exhausting accumulated air in systems under pressure and releasing or re-admitting large quantities of air while a system is being filled or drained, respectively. They shall have the same general requirements as specified for air and vacuum valves. Isolation valve shall be provided. Valves shall be suitable for wastewater with high solids content. Single body unit with air and vacuum valve and an air release valve in a single housing.

b. Materials: Cast-iron or ductile iron body and covers, NTP threaded inlet and outlet, with concave or skirted stainless steel float and trim.

c. Manufacturers:

1) APCO (Valve and Primer Corporation)
2) Crispin (Multiplex Manufacturing Company)
3) Golden-Anderson Valve Division (GA Industries, Inc.)
4) Val-Matic (Valve and Manufacturing Corporation)

I. Miscellaneous Valves (V-900+ Series)

1. Type V-900 Telescoping Valve

a. The valve shall utilize a low friction seal to mount to engage the slip tube and mount to the flange of the receiving pipe.

b. All welds shall be performed by welders with American Welding Society (AWS) certification.

c. Finish: Mill finish on stainless steel. Welds shall be sandblasted to remove weld burn and scale.

1) Materials:

Components	Materials
Slip Tube and Bail	Stainless Steel, Type 316L, ASTM A240
Stem	Stainless Steel, Type 316, ASTM A276
Fasteners, Nuts, and Bolts	Stainless Steel, Type 316, ASTM A276
Seal	Urethane or Neoprene
Lift Nuts	Bronze ASTM B584
Pedestals and Wall Brackets	Stainless Steel, Type 316L, ASTM A276

Operator Housing	Cast aluminum

d. ANCHOR BOLTS: minimum diameter of 1/2-inch, Type 316 stainless steel

e. Manufacturers:

1) Whipps, Inc., Series 310
2) Link-Belt Division of FMC Corp.
3) Envirex Division of Rexnord Corp

2. Type V-901 Mud Valve

a. Size: 4 Inches to 24 Inches

b. Cast-iron frame, yoke, and gate; heavy-duty 125-pound flange style, bronze seat, Buna-N seal, NRS, bronze stem and stem nut, 2-inch square operating nut, cast-iron floor box, Type 304 stainless steel extension stem; stem guides spaced for L/R of 200 maximum.

c. Manufacturers:

1) Clow Valve Company
2) Troy Valve
3) Trumbull Industries, Inc.
4) Whipps, Inc.

3. Type V-903 Solenoid Valve

a. Size: 1/4-inch to 2 inches

b. Two-way internal pilot operated diaphragm type, brass body, resilient seat suitable for air or water, solenoid coil molded epoxy, National Electrical Manufacturers Association (NEMA) insulation Class F, 120 volts alternating current (AC), 60-Hertz, unless otherwise indicated. Solenoid enclosure NEMA 250, Type 4 unless otherwise indicated. Size and normal position (when de-energized) as indicated on Valve Schedule.

c. Minimum operating pressure differential no greater than 5 psig, maximum operating pressure differential not less than 125 psig.

d. Manufacturers and Products:

1) ASCO
2) Skinner

PART 3 EXECUTION

3.1 VALVE INSTALLATION

A. General: All valves, actuating units, stem extensions, valve boxes, and accessories shall be installed in accordance with the Manufacturer's written instructions and as indicated. All gates shall be adequately braced to prevent warpage and bending under the intended use. Valves shall be firmly supported to avoid undue stresses on the pipe.

B. Access: All valves shall be installed with easy access for actuation, removal, and maintenance and to avoid interference between valve actuators and structural members, handrails, or other equipment.

C. Valve Accessories: Where combinations of valves, sensors, switches, and controls are indicated, the Contractor shall properly assemble and install such items so that all systems are compatible and operating properly. The relationship between interrelated items shall be clearly noted on shop drawing submittals.

D. Backflow preventers shall be installed in potable water lines where required by applicable codes or regulations, or wherever there is any danger of contamination, and where shown.

E. All backflow preventers, as well as air and vacuum release valves, shall have piped outlets to the nearest acceptable drain, firmly supported, and installed in such a way as to avoid splashing and wetting of floors

3.2 FIELD QUALITY CONTROL

A. Tests:

1. Pressure test valves at same time connected piping is tested.
2. Repair leaking joints.
3. Protect parts of valves and actuators that could be damaged by test.

3.3 INSPECTION, STARTUP, AND FIELD ADJUSTMENT

A. The Contractor shall demonstrate that all equipment meets the specified performance requirements. As necessary, an experienced, competent, and authorized service representative of the manufacturer of each valve type shall visit the site to perform the following tasks:

1. Assist the Contractor in the installation of the equipment, as necessary.

2. To inspect, check, adjust if necessary, and approve the installation.

3. To start-up and field-test the valves for proper operation.

4. To perform necessary field adjustments during the test period until the equipment installation and operation are satisfactory to the Engineer.

END OF SECTION

SECTION 40 05 57 – ACTUATORS FOR PROCESS VALVES AND GATES

PART 1 GENERAL

1.1 SUMMARY

A. The Contractor shall provide all valve and gate actuators and appurtenances, complete and operable, in accordance with the Contract Documents.

B. The provisions of this Section shall apply to all valves and gates, except where otherwise indicated in the Contract Documents.

C. Unit Responsibility: A single manufacturer shall be made responsible for furnishing the Work and for coordination of design, assembly, testing, and installation of the Work of each type of valve and gate; however, the Contractor shall be responsible to the Owner for compliance with the requirements of each valve and gate section. Unless otherwise indicated, the single manufacturer shall be the Manufacturer of the valve or gate.

D. Single Manufacturer: All electric actuators supplied will be from the same manufacturer. The actuators and valves shall be furnished and installed by the valve supplier as a unit assembly, complete in all respects. The actuators and gates shall be furnished and installed by the gate supplier as a unit assembly, complete in all respects.

1.2 SUBMITTALS

A. General: Submittals shall be furnished in accordance with Section 01 33 00 – Submittal Procedures.

B. Shop Drawings: Shop Drawings of all actuators shall be submitted together with the valve and gate submittals as a complete package.

1.3 QUALITY ASSURANCE

A. Qualifications

1. Technologies and devices used in the actuator must have a minimum of 5 years of commercial operating experience for that specific manufacturer.

B. Testing

1. Electric actuators shall be listed by a testing agency acceptable to the Owner in accordance with the latest version of the National Electrical Code, with the stamped or mark of that agency on the outside housing. Acceptable agencies include but are not limited to, UL, FM, and CSA.

PART 2 PRODUCTS

2.1 GENERAL

A. General: Unless otherwise indicated, all shut-off and throttling valves, and externally actuated valves and gates, shall be provided with manual or power actuators. The Contractor shall furnish all actuators complete and operable with mounting hardware, motors, gears, controls, wiring, solenoids, handwheels, levers, chains, and extensions, as applicable. All actuators shall be capable of holding the valve in any intermediate position between fully open and fully closed without creeping or fluttering. All wires of motor-driven actuators shall be identified by unique numbers.

B. Manufacturers**:** Where indicated, certain valves and gates may be provided with actuators manufactured by the valve or gate Manufacturer. Where actuators are furnished by different manufacturers, the Contractor shall coordinate selection to have the fewest number of manufacturers possible.

C. Materials: All actuators shall be current models of the best commercial quality materials and liberally sized for the maximum expected torque. All materials shall be suitable for the environment in which the valve or gate is to be installed.

D. Mounting: All actuators shall be securely mounted by means of brackets or hardware specially designed and sized for this purpose and of ample strength. The word "open" shall be cast on each valve or actuator with an arrow indicating the direction to open in the counterclockwise direction. All gear and power actuators shall be equipped with position indicators.

E. Standard: Unless otherwise indicated and where applicable, all actuators shall be in accordance with ANSI/AWWA C 540 - Standard for Power-Actuating Devices for Valves and Sluice Gates.

F. Functionality: Electric, pneumatic, and hydraulic actuators shall be coordinated with power and instrumentation equipment indicated elsewhere in the Contract Documents.

2.2 MANUAL ACTUATORS

A. General**:** Unless otherwise indicated, all valves and gates shall be furnished with manual actuators. Valves in sizes up to and including 4 inches shall have direct acting lever or handwheel actuators of the Manufacturer's best standard design. Larger valves and gates shall have gear-assisted manual actuators, with an operating pull of maximum 60 pounds on the rim of the handwheel. All buried and submerged gear-assisted valves, all gates, all gear-assisted valves for pressures higher than 250 pounds per square inch (psi), all valves 30 inches in diameter and larger, and where so indicated, shall have worm-gear actuators, hermetically-sealed and grease-packed, where buried or submerged. All other valves 6 inches to 24 inches in diameter may have traveling-nut actuators, worm-gear actuators, spur- or bevel-gear actuators, as appropriate for each valve.

B. Buried Valves: Unless otherwise indicated, all buried valves shall have stainless steel extension stems to grade, with square nuts or floor stands, position indicators, and cast-iron or steel pipe extensions with valve boxes, covers, and operating keys. Where so indicated, buried valves shall be in cast-iron, concrete, or similar valve boxes with covers of ample size to allow operation of the valve actuators. Covers of valve boxes shall be permanently labeled as requested by the local Utility Company or the Engineer. Wrench-nuts shall have a minimum of two operating keys, or one key per ten valves, whichever is greater, shall be furnished.

C. Chain Actuator: Manually activated valves with the stem located more than 6 feet above the floor or operating level shall be furnished with chain drives consisting of sprocket-rim chain wheels, chain guides, and operating chains, and be provided by the valve Manufacturer. The wheel and guide shall be of ductile-iron, cast-iron, or steel, and the chain shall be hot-dip galvanized steel or stainless steel, extending to 4 feet above the operating floor level. The valve stem of chain-actuated valves shall be extra strong to allow for the extra weight and chain pull. Hooks shall be provided for chain storage where chains interfere with pedestrian traffic.

D. Floor Boxes: Hot dip galvanized cast-iron or steel floor boxes and covers to fit the slab thickness shall be provided for all operating nuts in or below concrete slabs. For operating nuts in the concrete slab, the cover shall be bronze-bushed.

E. Manual Worm-Gear Actuator: The actuator shall consist of a single or double reduction gear unit contained in a weather-proof cast-iron or steel body with cover and minimum 12-inch diameter handwheel. The actuator shall be capable of 90-degree rotation and shall be equipped with travel stops capable of limiting the valve opening and closing. The actuator shall consist of spur or helical gears and worm-gearing. The spur or helical gears shall be of hardened alloy steel and the worm-gear shall be alloy bronze. The worm-gear shaft and the handwheel shaft shall be of 17-4 PH or similar stainless steel. All gearing shall be accurately cut with hobbing machines. Ball or roller bearings shall be used throughout. Actuator output gear changes shall be mechanically possible by simply changing the exposed or helical gearset ratio without further disassembly of the actuator. All gearing shall be designed for a 100 percent overload.

2.3 ELECTRIC MOTOR ACTUATORS

A. General

1. Actuators for GV-25-0211 and GV-25-0212 shall be non-intrusive, intelligent quarter-turn type, suitable for use on a nominal 480 volts of alternating current (VAC), 3-phase, 60-Hertz power supply and are to incorporate motor, integral

reversing starter, local control facilities, and terminals for remote control and indication connections within a self-contained, sealed enclosure.

2. All other electric motor actuators shall be non-intrusive, intelligent quarter-turn type, suitable for use on a nominal 120 VAC, single phase, 60-Hertz power supply and are to incorporate motor, integral reversing starter, local control facilities, and terminals for remote control and indication connections.

3. The actuator shall include a device to ensure that the motor runs with the correct rotation for the required direction of valve travel with either phase sequence of the 3-phase power supply connected to the actuator.

4. It shall be possible to carry out the setting of the torque, turns, and configuration of the indication contacts without opening or removing any electrical compartment covers.

5. Diagnostic information shall be available from both an integrally mounted display window and through non-intrusive means of reading and writing data to the actuator.

6. Two-way communication must be possible to facilitate downloading actuator setup.

7. During loss of electric power supply, fail in last valve position.

8. Operate from Full Closed to Full Open position or the reverse so that stem travel speed is 1-foot per minute.

B. Actuator Sizing

1. The actuator shall be sized to guarantee valve closure at the specified differential pressure. The safety margin of motor power available for seating and unseating the valve shall be sufficient to ensure torque switch trip at maximum valve torque with the supply voltage 10 percent below nominal.

C. Temperature

1. The actuator shall be capable of functioning in an ambient temperature ranging from minus 13 degrees Fahrenheit (F) (-25 degrees Celsius (C)) to plus 160 degrees F (+ 70 degrees C).

D. Torque Controller

1. The motor control printed circuit board (PCB) shall monitor and control the amount of torque output produced by the motor. Motor current shall be measured via a sensing resistor mounted on the PCB, which is digitally filtered and then

temperature compensated to produce the final calibrated output torque of the actuator. Torque setting shall be able to be set between 40 percent and 100 percent of rated torque and shall be adjustable via a non-intrusive setting tool using Infrared Data Access (IrDA) technology.

E. Motor

1. Motors shall be sized for a minimum 25 percent duty and a rated running torque equal to 35 percent of the operator capacity at a rated running time of 15 minutes, without exceeding the allowable National Electrical Manufacturer's Association (NEMA) temperature rise for class F insulation.

2. Motors shall be totally enclosed, non-ventilated motor with squirrel cage.

3. The electric motor shall be a low inertia motor. The motor shall be controlled by a toroidal transformer unit, which shall also include a thermostat for motor circuit protection. Motors shall be specifically designed and built by the actuator manufactured for electric actuator service.

4. If 3-phase powered actuators are provided, the actuator shall include automatic detection and correction of 3-phase power supply to assure proper open/close directions.

5. The motor control PCB shall restrict the amount of current to prevent damage to the motor, integral switching devices or toroid transformer. A 20A fuse in the transformer secondary circuit and anti-surge fuse in the primary circuit shall provide further protection.

6. Motor removal shall be possible without loss of lubricant.

F. Gearing and Gearbox

1. The actuator gearing shall be totally enclosed in a lubricant filled gearcase suitable for operation at any angle. Food grade lubricants approved by the manufacturer shall be used to lubricate the gearcase. Special or exotic lubricants shall not be used as they may be expensive or difficult to source in some locations.

2. Gearbox shall house and operate an appropriate coupling as follows:

   a. Coupling of operator to a multi-turn threaded rising stem valve shall be by means of threaded high tensile bronze top entry stem nut installed in a declutchable thrust base. Stem nut shall be keyed to mate with the internal bore and keyway of the operator sleeve.

   b. Coupling of operator to a multi-turn non-rising stem shaft shall be by a high-tensile aluminum/bonze drive bushing that is easily replaceable.

3. Final stage of the operator gear train shall consist of a steel worm and a bronze alloy worm gear. Other gears shall be heated treated alloy steel or high tensile bronze. Gear train shall be supported throughout by antifriction ball or roller bearings. The operator shall be self-locking in either motor or handwheel mode.

G. Hand Operation

1. A handwheel shall be provided for emergency operation engaged when the motor is declutched by a lever or similar means; the drive being restored to power automatically by starting the motor. The handwheel declutch mechanism shall include an output contact to indicate actuator manual operation. The hand/auto selection lever should be padlockable in both "Hand" and "Auto" positions. It should be possible to select hand operation while the actuator is running or start the actuator motor while the hand/auto selection lever is locked in "Hand" without damage to the drive train.

2. Handwheel shall be disengaged by motor operation.

3. Actuator shall incorporate a mechanism to track valve position while operated with the handwheel when electric power is off.

H. Position Setting Range

1. An intelligent micro controller on the motor PCB shall monitor and control two Hall Effect position sensors. Incremental encoders requiring batteries to retain settings upon loss of power shall not be accepted. The sensors shall employ a magnetic pulse system to measure the accuracy of the actuator’s stroke. Position limits shall be factory set to 90 degrees stop bolt position, with a limit setting range of 10 degrees to 1800 degrees, and maximum angular resolution to 0.1-degree.

I. Controls

1. Control power shall be provided from an integral 24 volts of direct current (VDC) or 120 VAC supply unless a separate power source is shown on the electrical drawings. The transformer shall be sized to operate at not more than 80 percent of rating with the connected load shown. The transformer shall have protective secondary fusing. Operators shall be provided with an integral control station. The control station shall include "LOCAL/OFF/REMOTE" and "OPEN/STOP/CLOSE" switches. Open and Close positions shall be configurable for momentary or maintained operation. Open, Close, and Stop

2. Connections for external remote controls shall be suitable for any one or more of the following methods of control:

   a. Open and Close

b. Overriding Emergency, Shutdown to Close (or Open) Valve from a "Make" Contact.

c. Two-Wire Control, Energize to Close (or Open), De-Energize to Open (or Close)

J. Set Up, Monitoring and Diagnostics

1. Facilities shall be provided for monitoring actuator operation and availability as follows:

2. Monitor (availability) relay, having one change-over contact, the relay being energized from the control transformer only when the Local/Off/Remote selector is in the "Remote" position and thermostat is not “tripped” to indicate that the actuator is available for remote (control room) operation.

3. Where required, it shall be possible to provide indication of thermostat trip and "Remote" selected as discrete signals.

4. A non-intrusive hand-held computer must be available, capable of two-way communication for uploading and downloading all variables for the actuator as well as performing detailed diagnostics.

5. Actuators shall include a diagnostic data logger module, which will store and enable download of historical actuator data logger information to permit analysis of changes in actuator or valve performance. It shall be possible for customer to access data via non-intrusive infrared means using either a notebook PC or hand-held windows CE based ‘Personal Digital Assistant (PDA)’ capable of duplex IrDA communications. Appropriate diagnostic software shall be provided to allow configuration and diagnostic information to be reviewed, analyzed, and reconfigured.

6. Provision shall be made to display valve torque demand as a percent of rated actuator torque and position simultaneously, so as to facilitate valve troubleshooting and diagnostics. The data logger shall also enable the retrieval of all configurable actuator date and time-stamped events, including the ability to search for occurrences of any particular event. Valve torque profiles shall be available in 1-degree positional increments. The diagnostics shall also enable retrieval of at least three types of alarms – actuator alarms, valve alarms, and control system alarms.

7. A Setting Tool shall be provided and used for non-intrusive calibration and interrogation of the actuator. This Setting Tool will provide speedy interrogation capabilities as well as security in a non-intrusive intrinsically safe watertight casing. The Setting Tool shall enable the user to extract and store actuator configuration and data logger files within the Tool. The Setting Tool shall store up to ten

configuration and four data logger files. Stored configuration and data logger files shall also be able to be uploaded to both the actuators and to diagnostic software provided by the actuator manufacturer.

K. Actuators for Modulation Duty

1. Use the above specification with the following changes and additions. The actuator shall incorporate a fast switching main control board that responds to signal changes within 100 milliseconds for modulating duty. The starter shall be suitable for 1500 starts per hour. If shown on the valve schedule, the actuator shall be capable of responding to a remote 4-20 milliampere (mA) control signal and positioning itself accordingly between 0-100% valve travel as well as providing a contactless transmitter to give a 4-20 mA analog signal corresponding to valve travel for remote indication. It shall be possible to adjust Dead Band (0-9.9 percent of travel) and a Motion Inhibit Timer (2-99 seconds) and select action upon loss of signal.

L. Enclosure

1. Double-sealed ‘O’ Ring design shall provide a termination chamber that is separate and sealed from the control chamber. Control components shall remain sealed and protected when the termination cover is removed. Actuators shall be sealed, watertight to NEMA 6, and shall at the same time have an inner watertight and dustproof 'O' ring seal between the terminal compartment and the internal electrical elements of the actuator fully protecting the motor and all other internal electrical elements of the actuator from ingress of moisture and dust when the terminal cover is removed on site for cabling.

2. Enclosure must allow for temporary site storage without the need for electrical supply connection.

3. All external fasteners shall be stainless steel.

   a. Actuators for explosion/hazardous applications shall in addition be certified flameproof for Zones 1 and 2 (Divisions 1 and 2) Group C, D, E, F, G hazardous areas.

   b. Double-sealed design shall provide a termination chamber that is separate and sealed from the control chamber. Control components shall remain sealed and protected when the termination cover is removed.

M. Remote Valve Position

1. In the event of a (main) power (supply) loss or failure, the position contacts must continue to be able to supply remote position feedback and maintain interlock capabilities.

2. A backup power source must be provided in the actuator to ensure correct remote indication should the actuator be moved manually when the power supply is interrupted.

3. The position of the actuator and valve must be updated contemporaneously, even when the power supply is not present.

4. Four contacts shall be provided which can be selected to indicate any position of the valve with each contact selectable as normally open or normally closed. The contacts shall be rated at 5A, 250 VAC, 30 VDC.

5. As an alternative to providing valve position, any of the four above contacts shall be selectable to signal one of the following:

   a. Valve Opening or Closing
   b. Valve Moving (Continuous or Pulsing)
   c. Motor Tripped on Torque in Mid-Travel
   d. Motor Stalled
   e. Actuator Being Operated by Handwheel
   f. Open or Close Interlock Active
   g. Electrostatic discharge (ESD) Active
   h. Motor Tripped on Torque in Mid-Travel
   i. Motor Tripped on Torque Going Open
   j. Motor Tripped on Torque Going Closed
   k. Pre-Set Torque Exceeded
   l. Valve Jammed
   m. Actuator Being Operated by Handwheel
   n. Lost Main Power Phase
   o. Customer 24 VDC or 24 VAC Supply Lost
   p. Battery Low
   q. Internal Failure Detected
   r. Thermostat Tripped

N. Local Position Indication

1. The actuator must provide a local display of the position of the valve, even when the power supply is not present. The display shall be able to be rotated in 90-degree increments in order to provide easy viewing regardless of actuator mounting position.

2. The local display should be large enough to be readable from a distance of 6 feet when the actuator is powered up. In addition to valve position, the local display shall also display torque in percent of rated value as well as customer-configurable multilingual text.

3. The actuator shall include a digital position indicator with a display from fully open to fully closed in 1-percent increments. Red, green, and yellow lights corresponding to Open, Closed, and Intermediate positions shall be included on the actuator. The digital display shall be maintained even when the power to the actuator is isolated.

O. Integral Push Button and Selector

1. Integral to the actuator shall be local controls for Open, Close, and Stop, and a local/remote selector switch padlockable in any one of the following three positions:

   a. Local Control Only
   b. Off (No Electrical Operation)
   c. Remote Control plus Local Stop Only.

2. It shall be possible to select maintained or non-maintained local control.

3. The local controls shall be arranged so that the direction of valve travel can be reversed without the necessity of stopping the actuator. It shall be possible to program the actuator without removal of any covers.

P. Actuator Networking

1. Provisions shall be made for connectivity with field bus control systems via a plug-in card. The following interfaces shall be available:

   a. Modbus

Q. Special Features

1. A liquid-crystal display (LCD) indicator panel shall provide continuous position and torque information as well as valve status, alarm, and diagnostic information.

2. Actuators shall include a diagnostic data logger module, which will store and enable download of historical actuator data logger information to permit analysis of changes in actuator or valve performance. It shall be possible for customer to setup, calibrate, and access actuator data via non-intrusive infrared means using any of three methods: Setting Tool, Laptop PC, or hand-held Windows CE-based ‘Personal Digital Assistant (PDA)’ capable of duplex IrDA communications. Appropriate diagnostic software shall be provided by the actuator manufacturer to allow configuration and diagnostic information to be reviewed, analyzed, and reconfigured. One hand-held programming setting tool shall be provided for every ten actuators shipped. Data download shall be carried out without removing any actuator covers.

3. Actuator calibration, setup, and communications settings shall be stored in non-volatile memory and shall be retained in the event of loss of power. In addition, battery power shall ensure that local indication of valve position is provided under power failure conditions.

4. Non-intrusive local control switches shall communicate switch position to the microprocessor without penetrations in the actuator housing.

5. Actuator's microprocessor shall continuously accept control signals (when in Remote) and communicate position, torque, status, alarm, and diagnostic data to the plant process control system via a data network connection.

R. Performance Test Certificate

1. Each actuator must be performance tested and individual test certificates shall be supplied free-of-charge. The test equipment should simulate a typical valve load and the following parameters should be recorded:

   a. Current at maximum torque setting
   b. Torque sensing tripping points in both the open and closed directions of travel
   c. Actuator Output Speed or Operating Time

2. In addition, the test certificate should record details of specification, such as gear ratios for both manual and automatic drive, closing direction, and wiring diagram code number.

S. Warranty

1. Each actuator shall be warranted for a minimum of 12 months of operation up to a maximum of 24 months from shipment. This warranty shall be held in effect regardless of pre-commissioning conditions in a typical indoor or outdoor environment as long as the actuator is not abused or disassembled. This warranty shall not require the use of special storage procedures (such as the use of indoor storage, plastic bags, desiccants, and the energization of heater(s) in order to be maintained.

T. Manufacturers

1. Rotork IQ Series
2. Auma SA Series
3. Flowserve Limitorque Accutronix MX Series

PART 3 EXECUTION

3.1 SERVICES OF MANUFACTURER

A. Field Adjustments

1. Field representatives of manufacturers of valves or gates with pneumatic, hydraulic, or electric actuators shall adjust actuator controls and limit-switches in the field for the required function.

3.2 INSTALLATION

A. It shall be the responsibility of the Contractor to handle, store, and install the equipment specified in this Section in strict accordance with the manufacturer's recommendations.

B. The Contractor shall review the installation drawings and installation instruction prior to installing the actuators.

3.3 FIELD TESTING

A. After installation, all actuators shall be field tested in the presence of the Engineer and Owner to ensure that all items of equipment are in full compliance with this Section.

B. Each actuator shall be cycled to confirm that they operate without binding, scraping, or distorting. The effort to open and close manual operators shall be measured and shall not exceed the maximum operating effort specified above. Electric motor actuators shall function smoothly and without interruption.

END OF SECTION

SECTION 40 05 59 – HYDRAULIC GATES

PART 1 GENERAL

1.1 SUMMARY

A. Section includes complete, tested and operating weir and slide gate equipment as shown on the Drawings and as specified herein.

B. Work Included in This Section:

1. Weir and slide gates and all appurtenances described within this section are to be furnished and installed by the General Contractor.

C. Standards Referenced

1. AWWA C513 and C561

1.2 SUBMITTALS

A. Shop Drawings and Product Data: Submit the following as a single complete initial submittal in accordance with Section 01 33 00:

1. Product data fully describing all items proposed for use to demonstrate that the equipment conforms to the specifications, including drawings, specifications, installation and design details, catalogue cut sheets. Include a list of materials of construction for all components.

2. System layouts and/or schematics, including connection and installation details.

B. Shop Drawings: Submit signed and sealed structural calculations and detailed drawings for the attachments and anchorage to the structure of the equipment and appurtenances in this section. Calculations shall conform to the requirements of Section 46 05 13 and Section 01 33 00.

C. Submit certification from the manufacturer that the equipment is capable of resisting seismic loads. Loading shall be as described in Section 01 31 13.

D. Manuals: Furnish manufacturer's installation, lubrication, and maintenance manuals, bulletins, and spare parts lists.

E. Affidavits: Furnish affidavits from the manufacturer stating that the gates and operators have been properly installed and tested and are ready for full time operation.

1.3 QUALITY ASSURANCE

A. All equipment furnished under this Section shall be of a manufacturer who has been regularly engaged in the design and manufacture of the equipment for at least five years. Demonstrate to the satisfaction of the Engineer that the quality is equal to equipment made by those manufacturers specifically named herein.

1.4 WARRANTY

A. The Manufacturer of the equipment shall warrant for 1-year from date of startup, not to exceed 18 months from date of shipment, that all equipment provided by the Manufacturer will be free from defects in material and workmanship. In the event a component fails to perform as specified or is proven defective in service during the warranty period, the Manufacturer shall repair or replace, at his discretion, such defective part.

PART 2 PART 2 PRODUCTS

2.1 SLIDE GATES

A. General: Provide aluminum or stainless-steel slide gates complete with slide, guides, seals, stems, operators, and all appurtenances to provide complete operational slide gates as shown in the Drawings, Gate Schedule, and as specified herein.

1. The complete system comprising the gate, slide, guides and appurtenances shall be furnished by the gate manufacturer, who shall be responsible for the compatibility of components and functional integrity. The size of each slide gate shall be suitable for the clear opening shown on the Drawings and in the Gate Schedule.

2. The slide gates as a whole and all their components shall be suitable for service in raw sewage. The gate shall be designed for manual and/or motor operation.

3. Slide gates shall conform to AWWA C513 and C561 except as modified herein.

B. Slide Gate Type: The slide gate shall be self-contained upward-opening, flush bottom channel embedded per the Gate Schedule and as shown on the drawings.

C. Slide Gates to be manufactured by Golden Harvest, Rodney Hunt; Hydrogate Corporation; Orbinox; or equal.

D. Slide Gate Construction:

1. Frame and guides: The gate frame shall be a rigid unit made of plates and structural shapes. The yoke supporting the operator shall not deflect more than 11360th of

the yoke span under the design thrust. The frame shall be constructed of aluminum (ASTM 8209 Alloy 6061 or ASTM 8308 Alloy 6061) or 304 stainless steel.

2. Slide (Disk): The slide shall be plate reinforced with structural shapes welded to the plate. The slide shall not deflect more than 11360th of the maximum dimension of the gate under the heads indicated in the Gate Schedule. The slide shall be constructed of same material of the frame.

3. Fasteners and anchor bolts: ASTM F593 and 594, Type 304 or 316 stainless steel.

4. Stem: The stem shall be ASTM A276, Type 304 or ASTM A582, Type 303 stainless steel with a diameter capable of withstanding in compression twice the rated output of the operator at 40-pound pull. The stem shall be supported so that the unsupported L/R ratio does not exceed 200.

5. Seals: Provide UHMW and neoprene seating faces and seals along the invert, top, and sides of the gate. Mount side seals to the frame guides. Bottom seal may be mounted on the slide or the frame.

6. Slide gates shall be unpainted.

2.2 WEIR GATES

A. General: Provide aluminum or stainless-steel weir gates complete with slide, guides, seals, stems, operators, and all appurtenances to provide complete operational weir gates as shown in the Drawings, Gate Schedule, and as specified herein.

1. The complete system comprising the gate, slide, guides, and appurtenances shall be furnished by the gate manufacturer, who shall be responsible for the compatibility of components and functional integrity. The size of each slide gate shall be suitable for the clear opening shown on the Drawings and in the Gate Schedule.

2. The weir gates as a whole and all their components shall be suitable for service in raw sewage. The gate shall be designed for manual and/or motor operation.

3. Weir gates shall conform to AWWA C561 except as modified herein.

B. Weir Gate Type: Weir gates shall be downward opening face-mounted, self-contained type as specified in the Gate Schedule. Weir Gates to be manufactured by Golden Harvest, Rodney Hunt; Hydrogate Corporation, Orbinox; or equal.

C. Weir Gate Construction:

1. Frame and guides: The gate frame shall be a rigid unit made of plates and structural shapes. The yoke supporting the operator shall not deflect more than 11360th of

the yoke span under the design thrust. The frame shall be constructed of aluminum (ASTM 8209 Alloy 6061 or ASTM 8308 Alloy 6061) or 304 stainless steel.

2. Slide (Disk): The slide shall be plate reinforced with structural shapes welded to the plate. The slide shall not deflect more than 11360th of the maximum dimension of the gate under the heads indicated in the Gate Schedule. The slide shall be constructed of same material of the frame.

3. Fasteners and anchor bolts: ASTM F593 and 594, Type 304 or 316 stainless steel.

4. Stem: The stem shall be ASTM A276, Type 304 or ASTM A582, Type 303 stainless steel with a diameter capable of withstanding in compression twice the rated output of the operator at 40-pound pull. The stem shall be supported so that the unsupported UR ratio does not exceed 200.

5. Seals: Provide UHMW and neoprene seating faces and seals along the invert, top and sides of the gate. Mount side seals to the frame guides. Bottom seal may be mounted on the slide or the frame.

6. All machined or bearing surfaces, including drilled and tapped holes, shall be coated with water-resistant protective grease and shall not be painted.

7. Rails and Toeboards: Provide Rails and Toeboards for gates spanning openings adjacent to handrails as shown in the drawings. Chain closures will not be acceptable.

2.3 MANUAL OPERATORS

A. Manually operated lifts shall be of the hand wheel type or single speed, removable crank type as shown in the Gate Schedule, conforming to applicable provisions of AWWA Standard C560 or C561 as amended herein. The handwheel or crank will be mounted atop the self-contained gate frame. After the gate has been "cracked" from its wedging devices, a maximum hand pull of 25 pounds shall be required to open the gate under the specified operating heads.

B. Provide hand wheel lift units with cast iron cap, hand wheel and a cast bronze lift nut. The lift nut shall be flanged and shall have ball thrust bearings above and below it to take the thrust developed during opening and closing of the gate. Adequate grease fittings shall be provided to lubricate the bearings and other moving parts. The rim of the hand wheel shall be cast smooth and be free of sharp edges. An arrow shall be cast in the rim of the hand wheel with the word "open" to indicate direction of rotation to open the gate.

C. Hand cranks shall have a maximum 15-inch operating radius and shall be provided with a revolving sleeve. All gears, sprockets and pinions shall be of steel and have cut teeth. Sufficient grease fittings shall be provided to allow lubrication of all moving parts, such as bearings, gears, etc. Ball thrust bearings shall be provided above and below the flange on the lift nut to take the normal thrust developed during opening and closing of the gate under the maximum specified operating heads. All other bearings shall be provided with bronze sleeves. An arrow shall be cast in the lift housing to indicate the direction of opening. It shall be readily visible to the operator. Lift nuts shall be of cast bronze.

D. All lifts shall be equipped with a transparent rigid butyrate stem cover with permanent marking to indicate full open, full closed, and gate level in 1-inch graduations. Lift nut shall be threaded with left hand threads for standardized valve operation.

2.4 MOTORIZED GATE OPERATORS

A. Motorized gate operators where called for in the gate schedules shall be electric motor driven.

1. All gearing shall be enclosed. Operator shall be equipped with auxiliary hand operator (side handwheel), stem cover, and shall be installed on a floor mounted operating pedestal. Each operator shall be designed with ample strength and power to operate the sluice gate under maximum heads as shown in the gate schedule, at a minimum speed of 1-foot per minute, without overloading the motor and shall be for indoor service.

2. Provide integral electric controls for open-close service including reversing starter, limit switches, torque switch, indicating lights and local-off-remote switch. Comply with AWWA C540. The motor shall be reversible, squirrel cage induction rated for 460 volts, 3 phase, 60 Hz with Class "F" insulating system. The motor shall be totally enclosed and nonventilated with all leads terminating within the limit switch compartment. The motor shall be of sufficient size to open or close the valve at 200 percent of maximum required breakaway torque. The motor shall operate at ±10 percent of rated voltage and shall be sufficient for one complete cycle without exceeding its temperature rating.

3. Units shall be equipped with hammer blow device to assist in opening the gate and permit motor to reach full speed before delivering torque.

4. Provide auxiliary contacts for remote monitoring of position and "ready" indication. Ready indication shall be indicated when the valve selector is in the "remote" position. At a minimum, contacts shall be provided for remote confirmation of the fully open and fully closed positions.

5. Manufacturer: Rotork or approved equal.

PART 3 EXECUTION

3.1 INSTALLATION

A. Equipment shall be installed in strict conformance with the manufacturer's installation instructions. Installation of slide and weir gates shall be in accordance with the requirements of AWWA C560 and C561 and as amended herein. The manufacturer of the slide gates shall furnish all gates, suitably designed, so that anchorage to thimble can be performed at the designed locations.

3.2 FIELD SERVICE

A. The manufacturer of the gates shall supply a competent field service engineer to thoroughly check and inspect the slide and weir gates after installation, place the gates in operation and make necessary adjustments, and instruct plant personnel in proper operating and maintenance procedures. Provide of minimum of 16 hours field service.

3.3 FIELD PAINTING

A. Non-submerged ferrous metal shall be painted in accordance with Section 09 90 00. Submerged surfaces need not be field painted but shall be touched up if required.

3.4 FIELD LEAKAGE TESTS

A. All slide gates and weir gates shall be given a field leakage test under the head conditions listed on the Drawings or in the gate schedule in these specifications. A qualified representative of the manufacturer shall be present to direct any adjustments required to reduce leakage to the specified amounts.

B. Allowable Leakage:

1. Slide and Weir Gates: The permitted leakage for the gates shall not exceed 0.1 gpm per foot of seating perimeter at the specified design seating head called for in the Schedule. The leakage shall not exceed 0.1 gpm per foot of seating perimeter at the specified design unseating head called for in the Schedule for heads of 10 feet or less.

C. For individual gates, the absence of a leakage test requirement for either seating or unseating head in the Schedule or the fact that the test heads are lower than the expected operating heads shall not relieve the requirement for satisfactory functioning at operating conditions. The tests and test levels are limited by expected limitations on water levels that will be available at the time the tests must be performed.

END OF SECTION

SECTION 40 61 96.23

PROCESS CONTROL DESCRIPTIONS – SCREEN AND SCREENINGS WASHER/COMPACTOR

PART 1 GENERAL

1.1 SUMMARY

A. Section includes:

1. Scope.
2. Abbreviations
3. Performance Requirements.
4. PLC I/O.
5. Fault Conditions.
6. Interlocks.
7. Control Sequence.
8. Testing.

1.2 SCOPE

A. This Section includes the required operation for Screen, Screenings and Washer/Compacter systems. It is to be used in conjunction with the P&IDs and the detailed control system design, the PLC I/O list and the controlled equipment specifications.

B. ABBREVIATIONS

1. HMI: Human/Machine Interface
2. I/O: Input / Output
3. OIT: Operator Interface Terminal
4. NEC: National Electrical Code
5. PC: Personal Computer
6. PCS: Process Control System
7. PLC: Programmable Logic Controller
8. SCADA: Supervisory Control and Data Acquisition
9. UPS: Uninterruptible Power Supply
10. I&C: Instrumentation and Controls
11. P&ID Process and Instrumentation Diagram

1.3 REFERENCES

A. Spec. Section 46 21 13 Mechanically Cleaned Bar Screens
B. Spec. Section 46 21 73 Screenings Washer/Compactor
C. Spec. Division 40

D. P&ID sheet for Screens, P-211
E. P&ID sheet for Washer/Compactor, P-212

PART 2 INPUTS, OUTPUTS INTERLOCKS & ALARMS

2.1 SYSTEM DESCRIPTION

A. The Screens receive raw sewage from the Influent Pump Station and remove large solids, rags and debris from the raw sewage. There are two mechanically cleaned bar screens with one manual screen in the headworks building. Each mechanical screen is able to handle the entire peak flow in the design year. The water level upstream and downstream of each mechanical screen is monitored. The rake will be activated to clean the screen when the level differential exceeds a pre-entered setpoint. The speed of the rake will increase to a higher speed if the level differential across the screen keeps increasing. The screen rake will turn off when the level differential drops below the setpoint and after the minimum screen rake run time to prevent intermittent equipment starting/stopping. Screenings pulled from the raw sewage by the screens will be conveyed with a sluice to a screenings washer compactor. The sluice and the screenings washer compactor will be interlocked with the screen rake operation, so that they are turned on when the rakes are on. The sluice and the screenings washer compactor will be turned off after an operator entered time delay once the rakes are off. The washed and compacted screenings will be deposited into a roll-off container. Water and organic material removed from the screenings during the washing and compaction process will be drained back to the screen channels.

2.2 EQUIPMENT LIST

A. Screen 1 Influent Gate
B. Screen 2 Influent Gate
C. Screen 1
D. Screen 2
E. VFD for Screen 1
F. VFD for Screen 2
G. Screen 1 Incoming Level Sensor
H. Screen 1 Outgoing Level Sensor
I. Screen 2 Incoming Level Sensor
J. Screen 2 Outgoing Level Sensor
K. Raw Sewage Flow Meter from Influent Pump 1 and 2
L. Raw Sewage Flow Meter from Influent Pump 3 and 4
M. Sluice Water Solenoid Valve
N. Screenings Washer/Compactor
O. Wash Water Solenoid Valve

2.3 PLC I/O

A. Discrete Inputs

1. Screen 1 Influent Gate, Ready
2. Screen 2 Influent Gate, Ready
3. Screen 1, Ready
4. Screen 1, Running
5. Screen 1, Auto
6. Screen 1, Fault
7. Screen 2, Ready
8. Screen 2, Running
9. Screen 2, Auto
10. Screen 2, Fault
11. Screenings Washer/Compactor, Running
12. Screenings Washer /Compactor, Auto
13. Screenings Washer /Compactor, Fault

B. Discrete Outputs

1. Screen 1 Influent Gate, Open Command
2. Screen 2 Influent Gate, Open Command
3. Screen 1 Influent Gate, Close Command
4. Screen 2 Influent Gate, Close Command
5. Screen 1, VFD Start Command
6. Screen 2, VFD Start Command
7. Screenings Washer/Compactor, Start
8. Sluice Water Solenoid Valve, Open
9. Sluice Water Solenoid Valve, Close
10. Wash Water Solenoid Valve, Open
11. Wash Water Solenoid Valve, Close

C. Analog Inputs

1. Screen 1 Incoming Level
2. Screen 1 Outgoing Level
3. Screen 2 Incoming Level
4. Screen 2 Outgoing Level
5. Screen 1, VFD Speed Feedback
6. Screen 2, VFD Speed Feedback
7. Raw Sewage Flow Meter from Influent Pump 1 and 2
8. Raw Sewage Flow Meter from Influent Pump 3 and 4

D. Analog Outputs

1. Screen 1, VFD Speed Command
2. Screen 2, VFD Speed Command

E. Network Communication Tags

1. Xx
2. Xx
3. Xx

F. SCADA User Input

1. Lead/Lag screen selection

2. Run time frequency to switch Lead and Lag screens

3. HI level setpoint to open Lag screen influent gate

4. HIHI level alarm setpoint

5. Differential Level setpoint to start the screen rake at low speed

6. Differential Level set point to start the screen rake at high speed

7. Minimum screen rake run time after starting

8. Time delay for the sluice water valve and screenings washer compactor to turn off after the screen rake turns off

2.4 FAULT CONDITIONS

A. Critical Faults

1. Screen 1 fail (motor overheat or overloaded)
2. Screen 2 fail (motor overheat or overloaded)
3. Screen 1 inlet gate fail
4. Screen 2 inlet gate fail
5. Screenings washer compactor fail

B. Informational Alarms

1. HI water level
2. HIHI water level
3. Sluice water solenoid valve fail
4. Wash water solenoid valve fail

2.5 INTERLOCKS

A. PROTECTION INTERLOCKS

1. N/A

B. PROCESS INTERLOCKS

1. Screenings sluice water solenoid valve opens when the rakes for Screen 1 or 2 is on; and screenings sluice water solenoid valve closes after a time delay once all the rakes are off.

2. Screenings wash compactor will start when the rakes for Screen 1 or 2 is on; and Screenings wash compactor will stop after a time delay once all the rakes are off.

3. Screenings washer compactor wash water solenoid valve opens when screenings washer compactor is on and closes when screenings washer compactor is off.

2.6 CONTROL SEQUENCE

A. NORMAL OPERATION

1. Normal operation of the screens and screenings washer compactor could be through the plant SCADA in either a MANUAL or AUTO mode. The operator can also use the local HAO switch at the equipment MCC to select HAND mode for local testing, troubleshooting purpose. There are E-button at each of screen and screening washer compactor as well. The primary control method is AUTO through the plant SCADA.

2. The Screens 1 and 2 will operate in Lead/Lag mode. The operator will determine which is Lead and which is Lag. The Plant Control System could also automatically switch the Lead and Lag screen based on the operator input run time threshold for each screen. The Lead screen influent gate will always be open. The influent gate will automatically close when the screen becomes the Lag.

3. The Lag screen influent gate will open automatically when the measured water level upstream of the Lead screen exceeds an operator input setpoint – HI setpoint.

4. The screen effluent gates are manual gates. They will be normally open.

5. There is a passive overflow to the 3rd manual screen when the water surface level rises and exceeds the overflow weir elevation – HIHI setpoint.

6. Alarms will be generated when the HI level and HIHI level are reached.

7. Operation of the screen will be based on the measured level differential upstream and downstream of the screen. When the operator input level differential (Rake

Run Low Speed setpoint) is exceeded the screen rake will be called to run at a low speed. The screen will continue to run until the level differential drops below Rake Run Low Speed setpoint, and for the minimum screen rake run time. The speed of the rake will increase to a higher speed if the level differential across the screen keeps increasing to exceed another operator input level differential setpoint (Rake Run High Speed setpoint).

8. Screenings will be conveyed to the screening's washer compactor via a sluice. The solenoid valve in the sluice water line will open when the rake for Screen 1 or 2 is on and will close after an operator specified time delay following all the rakes are turned off.

9. The screenings washer compactor will be called to run when the rake for Screen 1 or 2 is on and will stop after an operator specified time delay following all the rakes are turned off.

10. The solenoid valve feeding the washer compactor will be automatically controlled based on the operation of the washer compactor. When the washer compactor begins to run, the valve will open. The valve will remain open until the washer compactor stops operation.

B. FAULT OR FAILURE MODE OPERATION

1. If lead screen inlet gate is called to open but fails, the lag screen inlet gate will be automatically opened.

2. If the level sensor fails, turn off the associated screen and bring the other screen online.

C. MANUAL/MAINTENANCE OPERATION

1. There is an E-stop in the local control push button provided at each screen unit and screenings washer compactor.

2. HOA switch is provided for each screen unit and screenings washer compactor at the MCC.

3. In the SCADA MANUAL Mode, all the motors and valves can be controlled manually by the operator through the SCADA system.

4. In the LOCAL HAND mode, the operator can turn on or off all the equipment at the local motor control center.

PART 3 EXECUTION

3.1 PRE-OPERATIONAL TESTING

A. Prior to equipment operation it must be inspected for mechanical interference and proper installation must be certified by the manufacturer or supplier. All fasteners are to be torqued to manufactures specifications. It must be verified that the proper lubricant(s) have been installed and any couplings or drive belts/mechanisms are installed correctly.

B. At power up and prior to operation all discrete and analog signals interfacing with or comprising the equipment or the system the equipment is a part of must be verified.

C. Ensure motor overcurrent devices are set correctly.

D. Rotation of motor driven equipment is to be verified.

3.2 OPERATIONAL TESTING

A. Verify Motor current is within expected range immediately upon operation of all equipment.

B. Verify proper response of all associated sensors and controlled equipment.

C. Verify correct response to PLC requests for start/stop and fault reset.

D. Verify proper speed control and feedback.

E. Verify Motor current is within expected range immediately upon operation of all equipment.

3.3 FUNCTIONAL TESTING

A. Verify the mechanical rakes are operating as intended.

B. Verify the mechanical rakes will operate in both low speed and high speed.

C. Verify all process interlocks are operating as intended. Verify the sluice and the washer/compactor start up with the startup of the screens. Verify the wash water and compactor turn off after a delay once the screens turn off.

D. Verify the actuated gates are operating as intended. Ensure that the gates will open and close under typical lead lag operation. Verify that the lag gate opens as the water surface elevation in the influent channels reaches the HIHI setpoint.

END OF SECTION

SECTION 40 61 96.43

PROCESS CONTROL DESCRIPTIONS – AERATION BLOWERS

PART 1 GENERAL

1.1 SUMMARY

A. This Section includes the required operation for the aeration blowers. It is to be used in conjunction with the P&IDs and the detailed control system design, the PLC I/O list and the controlled equipment specifications.

B. ABBREVIATIONS

1. HMI: Human/Machine Interface
2. I/O: Input / Output
3. OIT: Operator Interface Terminal
4. NEC: National Electrical Code
5. PC: Personal Computer
6. PCS: Process Control System
7. PLC: Programmable Logic Controller
8. SCADA: Supervisory Control and Data Acquisition
9. UPS: Uninterruptible Power Supply
10. I&C: Instrumentation and Controls

1.2 REFERENCES

A. Spec. Section 43 11 31 - Single Stage Rotary Lobe Blowers
B. Spec. Division 40
C. P&ID sheet P-411, Aeration Blowers
D. P&ID sheet P-422, Aeration Basin - Air

PART 2 CONTROL DESCRIPTIONS

2.1 SYSTEM DESCRIPTION

A. A total of four aeration blowers will be installed in the blower room to provide process air to two aeration basins at Sweet Home WWTP through year 2043. Two of the blowers (BLO-440-01 & BLO-440-02) are sized to provide 1200 scfm of air each. The other two (BLO-440-03 & BLO-440-04) are sized to provide 2200 scfm of air each.

B. Each aeration basin has four process air droplegs to the diffusers. Each dropleg has a flow control valve and flow meter. Each zone is equipped with one DO probe.

2.2 PLC I/O

A. Discrete Inputs

1. Blower status
2. Blower inlet filter differential pressure HI
3. motor oil temperature HI
4. Blower fault

B. Analog Inputs

1. Blower discharge pressure
2. Blower discharge temperature
3. Blower VFD speed
4. DO
5. Air flow rate
6. Control valve open position

C. Discrete Outputs

1. Blower start
2. Control valve open
3. Control valve close

D. Analog Outputs

1. Blower VFD speed
2. Header pressure set point
3. DO set points
4. Air flow set points
5. Operator adjustable air flow incremental unit

E. Network Communication Tags

1. Xx
2. Xx
3. Xx

2.3 FAULT CONDITIONS

A. Critical Faults

1. Blower 1 fail
2. Blower 2 fail
3. Blower 3 fail
4. Blower 4 fail

B. Informational Alarms

1. Blower 1 oil temp HI
2. Blower 1 inlet filter differential pressure HI

2.4 INTERLOCKS

A. PROTECTION INTERLOCKS

1. N/A

B. PROCESS INTERLOCKS

1. N/A

2.5 CONTROL SEQUENCE

A. NORMAL OPERATION

1. Normal operation of the blowers can be through the plant SCADA in either a MANUAL or AUTO mode. The operator can also use the local HAO switch near the blower sound enclosure to put the blower in HAND mode for local testing, trouble shooting purpose. The primary control method is AUTO through the plant SCADA.

2. In AUTO mode, the blowers will be operated in a LEAD, LAG1, LAG2 and STANDBY sequencing. The LEAD, LAG and STANDBY blower units will be operator selectable. Blowers will be turned on and off to maintain a desired air header discharge pressure.

   In AUTO mode, the blowers will turn on and off and speed up and down to maintain a set pressure in the discharge header. Control valves corresponding to each aeration piping will modulate to maintain an operator adjustable target dissolved oxygen (DO) or air flow rate value to each aerobic zone. A corresponding DO probe or air flow meter will provide data values to compare to the operator adjustable targeted values. Based on this comparison, the control valves will open or close or modulate between 80 percent open to 20 percent open to increase or decrease the air flow to each aeration basin. If the measured DO or air low rate is lower than the targeted value, the control valve will modulate slightly open to increase the air flow by a certain operator adjustable incremental unit as measured by the flow meter. If the measured DO or air low rate is greater than the targeted value, the control valve will modulate slightly closed to decrease the air flow by a certain operator adjustable incremental unit as measured by the flow meter. There will be an operator adjustable time delay between each valve modulation to allow the measured value to react. If the aeration discharge header pressure transmitter fails, there will be an alarm and the blower header pressure control loop will be placed into Manual and set at last output.

B. FAULT OR FAILURE MODE OPERATION

1. If blower is supposed to be on, but has a FAIL alarm, SCADA will try to start the next blower in the sequence.

C. MANUAL/MAINTENANCE OPERATION

1. In the SCADA MANUAL mode, the blowers and control valves will be controlled manually by the operator through the SCADA system

2. In the LOCAL HAND mode, the blowers will be turned on or off by the local motor control center. Control valves will be controlled locally with OPEN STOP CLOSE push button stations.

PART 3 TESTING

3.1 PRE-OPERATIONAL TESTING

A. Prior equipment operation it must be inspected for mechanical interference and proper installation must be certified by the manufacturer or supplier. All fasteners are to be torqued to manufactures specifications. It must be verified that the proper lubricant(s) have been installed and any couplings or drive belts/mechanisms are installed correctly.

B. At power up and prior to operation all discrete and analog signals interfacing with or comprising the equipment or the system the equipment is a part of must be verified.

C. Ensure motor overcurrent devices are set correctly.

D. Rotation of motor driven equipment is to be verified.

3.2 OPERATIONAL TESTING

A. Verify Motor current is within expected range immediately upon operation of all equipment.

B. Verify proper response of all associated sensors and controlled equipment.

C. Verify correct response to PLC requests for start/stop and fault reset.

D. Verify proper speed control and feedback.

E. Verify Motor current is within expected range immediately upon operation of all equipment.

3.3 FUNCTIONAL TESTING

A. Verify that the blowers are operating as intended. Verify the blowers speed up and slow down as the operator setpoint changes. Verify that changes to the control valves change the speed of the blowers.

B. Verify LAG1, LAG2, and STANDBY blowers start up as the air demand changes.

END OF SECTION

SECTION 40 80 01 – PROCESS PIPING TESTING

PART 1 GENERAL

1.1 SUMMARY

A. Hydrostatic test for pressure and gravity piping, and pneumatic test for pressure and gravity piping.

B. Systems to be tested, type of test to be performed, and test pressure shall be as specified in other sections of Specifications and Pipe Schedule.

1.2 SUBMITTALS

A. Testing Plan:

1. 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) to be tested.

B. Certifications of Calibration: Testing equipment.

C. Certified Test Report.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.1 PREPARATION

A. Notify Engineer in writing 5 days in advance of testing. Perform testing in presence of Engineer.

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 5 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 2 days.

3. Prior to test, remove or suitably isolate appurtenant instruments or devices that could be damaged by pressure testing.

C. Test section may be filled with water and allowed to stand under low pressure prior to testing.

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

3.2 HYDROSTATIC TEST FOR PRESSURE PIPING

A. Fluid: 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.

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 30 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.

C. Buried Piping:

1. Test after backfilling has been completed.

2. Expel air from piping system during filling.

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 2 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.

6. Maximum Allowable Leakage:

$$L = \frac{NDP^{1/2}}{7{,}400}$$

Where:

L = Leakage, gallons per hour

N = Number of joints under test

D = Nominal diameter of piping, in.

P = Average pressure during test, pounds per square inch

7. Correct leakage greater than allowable, and retest as specified.

3.3 PNEUMATIC TEST FOR PRESSURE PIPING

A. Do not perform on:

1. Polyvinyl chloride (PVC) or chlorinated polyvinyl chloride (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 PSI gauge (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 pressure 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 10 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 visual 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.

3.4 HYDROSTATIC TEST FOR GRAVITY PIPING

A. Testing Equipment Accuracy: Plus or minus 1/2-gallon water leakage under specified conditions.

B. Maximum Allowable Leakage: 0.16 gallons per hour per inch diameter per 10 feet. Include service connection footage in test section, subjected to minimum head specified.

C. Exfiltration Test:

1. Hydrostatic Head:

    a. At least 6 feet above maximum estimated groundwater level in section being tested.

    b. No less than 6 feet above inside top of highest section of pipe in test section, including service connections.

2. Length of Pipe Tested: Limit length such that pressure on invert of lower end of section does not exceed 30 feet of water column.

D. Infiltration Test:

1. Groundwater Level: At least 6 feet above inside top of highest section of pipe in test section, including service connections.

E. Piping with groundwater infiltration rate greater than allowable leakage rate for exfiltration will be considered defective even if pipe previously passed a pressure test.

F. Defective Piping Sections: Replace and retest as specified.

3.5 PNEUMATIC TEST FOR GRAVITY PIPING

A. Equipment:

1. Calibrate gauges at start of each testing day. Engineer will witness calibration.

2. Install gauges, air piping manifolds, and valves at ground surface.

3. Provide pressure release device, such as rupture disc or pressure relief valve, to relieve pressure at 6 pounds per square inch (psi) or less.

4. Restrain plugs used to close sewer lines to prevent blowoff.

B. Procedure:

1. Require that no person enter manhole where pipe is under pressure.

2. Slowly introduce air into pipe section until internal air pressure reaches 4 psi greater than average back pressure of groundwater submerging pipe.

3. Allow 2 minutes minimum for air temperature to stabilize.

C. Allowable Leakage: Test section will be considered defective when time required for pressure to decrease from 3.5 psi to 2.5 psi greater than average back pressure of groundwater submerging pipe is less than that computed using values from following table:

Table 1*					
A Pipe Diameter (Inches)	B Time per Foot up to Length in Col C (Seconds)	C Test Length (Feet)	D Test Time for any Length Between Col C & E (Min:Sec)	E Length at Which Time in Col F Applies (Feet)	F Time per Foot for Total Length (Seconds)
4	0.18	636	1:54	1,114	0.10
6	0.40	424	2:50	743	0.23
8	0.71	318	3:47	557	0.41
10	1.11	255	4:43	446	0.63
12	1.60	212	5:40	371	0.91
15	2.50	170	7:05	297	1.42
18	3.62	141	8:30	248	2.06
21	4.92	121	9:55	212	2.81

Table 1*					
A Pipe Diameter (Inches)	B Time per Foot up to Length in Col C (Seconds)	C Test Length (Feet)	D Test Time for any Length Between Col C & E (Min:Sec)	E Length at Which Time in Col F Applies (Feet)	F Time per Foot for Total Length (Seconds)
24	6.42	106	11:20	187	3.67
Example: 15-inch diameter pipe: For 150 feet, T = 2.50 sec (Col B) x 150 ft = 375 sec = 6:15 For 250 feet, T = 7:05 (Col D) For 500 feet, T = 1.42 sec (Col F) x 500 ft = 710 sec = 11:50 *Based on 0.003 cfm per square foot with a minimum significant loss of 2 cfm and a maximum loss of 3.5 cfm.					

D. Piping with groundwater infiltration rate greater than allowable leakage rate for exfiltration will be considered defective even if pipe previously passed a pressure test.

E. Defective Piping Sections: Replace and retest as specified.

3.6 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 satisfactorily completed.

END OF SECTION

SECTION 41 12 13 – SCREW CONVEYOR SYSTEM

PART 1 GENERAL

1.1 SUMMARY

A. There shall be furnished a shaftless screw conveyor including support legs and inlet hopper with drivers and features specified in this Section and scheduled below. All equipment shall be provided by a single manufacturer. The shaftless screw conveyor shall be capable of conveying dewatered municipal anaerobically digested sludge.

B. Unit Responsibility: All equipment supplied under this section shall be furnished by or through a single Manufacturer who shall coordinate with the Contractor, the design, fabrication, delivery, installation, and testing of the dewatering screw press and screw convey system, and components. The Manufacturer shall have the sole responsibility for the coordination and performance of all components of the screw conveyor system with the performance and design criteria specified herein.

C. The Manufacturer should also be the one to supply the dewatering screw press system as described in Section 46 76 27 – Dewatering Screw Press.

D. The Contractor shall be responsible to coordinate all details of the screw conveyor system with other related parts of the Work, including verification that all structures, piping, wiring, and equipment components are compatible. The Contractor shall be responsible for all structural and other alterations in the Work required to accommodate the equipment differing in dimensions or other characteristics from that contemplated in the Contract Drawings or Specifications.

1.2 REFERENCES

A. American Bearing Manufacturers Association (ABMA)
B. American Gear Manufacturers Association (AGMA)
C. American National Standards Institute (ANSI)
D. American Society of Mechanical Engineers (ASME)
E. American Welding Society (AWS) D1.1, Structural Welding Code
F. Conveyor Equipment Manufacturer's Associations (CEMA)
G. National Electric Code (NEC)
H. National Electrical Manufacturers Association (NEMA)

1.3 SUBMITTALS

A. Submit as specified in Section 01 33 00 – Submittal Procedure.

B. Product Data:

1. Submit data completely describing product including plan and section views and listings of materials of construction.

C. Shop Drawings:

1. Complete manufacturer fabrication/assembly drawings including location of conveyor relative to locations of associated feed equipment, inlet chute and leg supports.

2. Certified drawings showing dimensions, weights, loading information and location of all components.

3. Wiring diagrams for all motors and electrical field instrumentation furnished.

D. Structural Calculations

1. Structural calculations prepared, sealed, and signed by a registered professional structural engineer in the State of Oregon.

a. Structural anchor points to concrete foundation.
b. Seismic loads on frame and anchor bolts.

E. Resume of Technician to perform conveyor adjustments, inspections, observations of test operations, supervision of functional and performance testing, and training.

F. Training Course Outline

G. Operating and Maintenance Manuals: Include complete lubrication, maintenance, and operation instructions, including initial start-up instructions, and unloading and handling methods.

H. Manufacturer's references.

I. Quality Control Submittals:

1. Special shipping storage, protection, and handling instructions

2. Manufacturer's Installation Instructions

3. Factory Test Results

1.4 QUALITY ASSURANCE

A. Manufacturer Qualifications: Consideration will be given only to the equipment of Manufacturers who are regularly engaged in such work and thoroughly experienced in the design and manufacture of screw press equipment specifically manufactured for municipal, secondary treated, waste activated sludge. Manufacturer shall meet the requirements below:

1. Have a minimum of 5 years of experience of producing substantially similar equipment and show evidence of satisfactory operation in North America for conveying municipal wastewater treatment plant sludge.

2. Must have a company-owned service and parts facility within the continental United States.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Contractor shall unload, store, and handle the equipment per the manufacturer's instructions.

1.6 WARRANTY

A. Warranty shall extend for 12 months after start-up or 18 months after delivery, whichever comes first.

B. Warranty shall include all parts, labor, and coatings for repairing or replacing equipment that fails during the warranty period. Defects occurring within the warranty period shall be repaired or replaced by the manufacturer at no cost to the Owner.

1.7 PROJECT CONDITIONS

A. Deliver shaftless screw conveyor as completely assembled as practical to minimize field assembly. Contractor shall be responsible for unloading and any necessary field assembly. Contractor shall contact manufacturer for screw conveyor field assembly requirements during bid.

1.8 SEQUENCING AND SCHEDULING

A. Coordinate work with restrictions as specified.

PART 2 PRODUCTS

2.1 MANUFACTURER

A. Shaftless screw conveyor shall be provided by FKC Co., LTD.

B. Or pre-approved equal. Screw press manufacturer seeking pre-approval must submit application a minimum of 3 weeks prior to bid day. Charges for additional engineering to alter site drawings to meet the intention of the specification shall be at the cost of the manufacturer requesting such change. The necessary submission to be considered a pre-approved equal shall include the following information:

1. Product data sheet

2. Site Specific Proposal Drawing

3. Installation drawings and instructions

4. Operations and Maintenance (O&M) Manual

5. An employee list of in-house design engineers along with their respective locations and resumes.

6. An employee list of in-house controls engineers along with their respective locations and resumes.

7. An employee list of in-house application engineers along with their respective locations and resumes.

8. An employee list of in-house project managers along with their respective locations and resumes.

9. An employee list of in-house field service technicians along with their respective locations and resumes.

2.2 SHAFTLESS SCREW CONVEYOR DESCRIPTION

A. Shaftless screw conveyor system shall be capable of conveying dewatered municipal anaerobically digested sludge.

B. Shaftless screw conveyor with components as specified in this Section and shown on the Drawings and as required for a complete and functional shaftless screw conveyor, including:

1. Shaftless screw conveyor with all 304 stainless steel wetted parts
2. Spiral Flight, Shaftless
3. End Shaft
4. Speed Reducer
5. Motor
6. Trough and Liners
7. Covers, bolt-on
8. Inlet chute
9. Support Legs, 304 stainless steel
10. Zero Speed Switch
11. Emergency Stop Pull-Cord

12. Anchor age/seismic support calculations

C. Design Requirements:

1. Shaftless screw conveyor shall be suitable for both intermittent and continuous loading and operation.

2. Shaftless screw conveyor minimum performance requirements

Type of Biosolids	Anaerobically Digested Sludge
Dewatered Biosolids, % total solids (TS)	18 to 22 % total solids
Design Capacity @ 35% Trough Loading	300 dry pounds per hour 1,200 wet pounds per hour 26.5 cubic feet per hour

3. Motor Characteristics – as described in this Section.

D. Tag Numbers.

1. Shaftless Screw Conveyor and Motor: CON-260-01
2. Shaftless Screw Conveyor Zero Speed Switch: XX
3. Shaftless Screw Conveyor Emergency Stop Switches: XX

2.3 MATERIALS

A. Wetted Parts: Stainless Steel, Type 304, unless otherwise indicated.

1. Troughs and inlet chute: 10-gauge
2. Covers: 10-gauge
3. Drive and end plates: 3/8-inch minimum

B. Support Legs: 304 stainless steel.

C. Spiral Flights: Cold-formed flat hot-rolled carbon, spring steel bar, Brinell 220 minimum.

1. For 9-inch diameter conveyor, use 3/4- by 2-1/2-inch.

2. For 12-inch diameter conveyor, use 1- by 3-inch.

D. Drive Shaft: AISI 1045.

E. Drive Unit: As scheduled.

F. Wear Liners: UHMW, 1/2-inch thickness, one color.

G. Other parts: Coated carbon steel

H. Miscellaneous hardware, including bolts, nuts, and washers in the wetted area: 18-8 Stainless steel.

2.4 SPIRAL FLIGHTING

A. Design spiral flighting to convey material without a center shaft and designed with the stability to prevent distortion and jumping in the trough.

B. Connect spiral flighting to the drive shaft:

1. For 9-inch conveyors, connection by welding the spirals to a 3-1/2 OD by 1/4-inch thick inner shaft sleeve. Shaft is inserted into sleeve and fastened by two cross bolts.

2. For 12-inch conveyors, connection by welding the spirals to a 5-1/2 OD by 3/8-inch thick inner shaft sleeve. Half-inch plate is welded to sleeve. Another 1/2-inch plate is welded to the drive shaft. The two 1/2-inch plates are fastened to each other by four 1/2-inch 304 stainless steel bolts, nuts, and washers.

C. Spiral Flights to be concentric to within 1/16-inch.

2.5 DRIVE SYSTEM

A. The drive units shall be hollow shaft-mounted, roller-bearing gear motor rated a minimum AFMA Class II, single or double reduction or triple reduction.

B. Drive finish shall be severe duty wash-down surface protection finish as provided by manufacturer.

C. Drive system shall consist of an electric motor as required to provide full load capacity and also to withstand the full starting torque of the system.

D. Screw speed shall be electronically controlled by means of a motor starter in a NEMA 4X enclosure.

E. Maximum conveyor speed shall be 30 revolutions per minute or lower.

F. V-belt driven speed reducer, or chain driven reducers are not permitted.

G. Speed Reducer:

1. Speed reducer shall be SEW Eurodrive Reducer or equal.

H. Shaftless Screw Conveyor Motor:

1. Provide inverter rated, severe duty motor, 1.15 SF, NEMA Premium Efficiency, cast iron frame with manufacturer's standard, corrosion resistant, epoxy finish.

2. Minimum screw press motor requirements of 3.0 HP, (480v/3 phase)

I. Motors shall be mounted at the end of the conveyors as shown in the contract plan drawings.

2.6 TROUGH AND LINERS

A. Construction shall be of U-trough design with gasketing at each trough flange. Trough sections in 8-foot lengths.

B. Trough end plates shall be 3/8-inch minimum, removable, with wastepack seal at drive end.

C. Provide each conveyor with a 2-inch NPT drain outlet at the lowest end of the conveyor.

D. Liner sections in 4-foot lengths. Liners are 1/2-inch minimum plastimeric-type ultra-high molecular weight (UHMW) polyethylene, 1 color.

2.7 INLET CHUTE

A. Purpose: Convey the dewatered cake from the screw press discharge box to the inlet trough of the shaftless screw conveyor.

B. Fabricated and provided by the shaftless screw conveyor manufacturer.

C. Construct of 12-gauge wall and flange thickness for connection to conveyors.

D. Provide chute with external body reinforcing stiffeners as required.

E. Provide chute with both the interior and exterior surfaces smooth, free from sharp edges, burrs, and projections, and with all welds ground smooth and all edges and corners rounded.

F. The minimum incline angle of the chute is 60 degrees.

G. The chute shall not be supported by any element of the screw press frame.

H. No part of the chute shall come in contact with the screw press drive, screw, flight, nor interfere with normal operation of the screw press.

I. Bolt hole pattern for fastening to screw press to match pattern at bottom of screw press discharge box. Bolts and washers for this connection included with shaftless screw conveyor.

2.8 INSTRUMENTATION AND CONTROLS

A. Controls for the screw conveyor system will be incorporated directly into the Plant Control System without equipment main control panel. The Manufacturer shall be responsible for providing the required sizing information of the electrical components in the Manufacturer's scope of supply. All motors shall operate at 480 VAC unless specified otherwise

B. All electrical equipment shall conform to applicable standard of NEMA and the NEC.

1. Both power and control equipment shall be insulated for not less than 600 volts even though operating voltages may be lower.

C. Shaftless screw conveyor motor shall have power control from a motor starter housed in the plant motor control center.

D. Shaftless screw conveyor manufacturer shall provide motion sensor probe and control relay box as follows:

1. Manufacturer: Siemens Milltronics MFA 4P or equal:

    a. 100/115.200 VAC, 50/60 Hz, 15 VA.
    b. Two relay outputs with SPDT fail-safe contracts operating in unison.
    c. Two to 3,000 pulses per minute adjustment setpoint range.
    d. Polycarbonate NEMA 4/4X Enclosure for relay circuit board
    e. MSP-12 standard probe cast aluminum body and zinc flange.

E. Shaftless screw conveyor manufacturer shall provide emergency pull-cords and safety switches and as follows:

1. Manufacturer: Omron STI or equal:

    a. Housing: Heavy-duty painted zinc-based die-cast alloy.

    b. Indicator: Glass-filled nylon.

    c. Switch color: Yellow body, blue reset button.

    d. Switch lockout on cable pulled and cable slack.

    e. Cable-status indicator on switch lid.

    f. 6A @120 VAC, 3A @ 240 VAC

g. Two N.C. direct-operating safety contacts.

h. One N.O. direct-opening auxiliary contacts.

i. IP67 enclosure type for switches.

j. All cables, eyebolts, hooks, springs, and clips necessary to run pull cords down both sides of the conveyor.

2.9 ANCHOR BOLTS

A. Anchor bolts will be sized by the screw press Manufacturer and provided by the Contractor.

2.10 FINISHES

A. Motors and gearboxes for the screw press and flocculation tank shall be prepared and coated with the manufacturer's standard surface preparation, prime coat, and topcoat for corrosion resistance.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. The Contractor shall provide all hardware and accessories required for installation.

C. Manufacturer's Field Services

1. Include the following:

a. Inspection, Functional/Operational Testing: Two trips for a total of 2 days, 8 hours per day.

2. Additional trips resulting from failed tests shall be the sole responsibility of the manufacturer.

3.2 SHOP TESTING

A. Units shall be full assembled at the factory and test run for 15 minutes to check for equipment tolerances and proper operation.

B. Conveyors shall be corrected, as necessary.

3.3 FIELD QUALITY CONTROL

A. Witnessing: All field testing shall be witnessed by the Engineer.

B. A representative of the screw press manufacturer shall be provided for the following:

1. To inspect the equipment and installation

2. To make any field adjustments to ensure proper equipment operation

3. To furnish affidavit stating that the dewatering system has been tested and is ready for installation as specified.

4. To inspect start-up

C. Manufacturer shall inspect system before initial start-up and certify that system has been correctly installed and prepared for start-up.

D. Training:

1. Provide operator training for at least 1 day on-site by factory trained representative. Training can be coordinated and occur during same days as functional/operational testing. Operator training to include:

    a. Operations and inspection training.
    b. Safety instruction.
    c. Preventative maintenance instruction.

END OF SECTION

SECTION 43 11 11 - SINGLE STAGE ROTARY LOBE BLOWERS

PART 1 GENERAL

1.1 SUMMARY

A. This section includes the furnishing and installation of the single stage rotary lobe blowers for aeration air supply including all appurtenances for complete and functioning air system.

B. Work included in this section:

1. Furnishing and installing four process rotary lobe blowers complete with materials and appurtenances.

2. Contractor shall coordinate submittals, and startup and testing services with supplier.

C. The entire package and its components shall comply with all applicable safety and environmental regulations.

1.2 REFERENCES

A. American Society of Testing Materials (ASTM):

1. A-48 - Standard Specification for Grey Iron Castings

B. International Organization for Standardization (ISO)

1. ISO 8573-1 - Compressed Air: Contaminants and Purity Classes

2. ISO 1217 - Displacement Compressors: Acceptance Tests

3. ISO 1940 - Balance Quality Requirements for Rotors in a Constant (Rigid) State

C. American National Standards Institute (ANSI)

1. ANSI S2.19.G2.5 - Balance Quality Requirements of Rigid Motors

D. American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE)

1. ASHRAE 52.2 - Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size

E. Underwriters' Laboratory (UL)

1. UL 94 - Standard for Safety of Flammability of Plastic Materials for Parts in Devices and Appliances

1.3 SUBMITTALS

A. Shop Drawings and Product Data: Submit the following as a complete initial submittal in accordance with Section 01 33 00.

1. All products required for submittal under this section shall be furnished in one complete package.

2. All submittal dimensions, calculations and other information to be in USA English units of measure.

B. Product Data

1. Product data fully describing all items proposed for use to demonstrate that the equipment conforms to the Specifications.

2. Blower characteristics, specifications, and performance

a. Descriptive brochures and blower data.

b. Predicted performance curves indicating speed, capacity, horsepower, and input wire kilowatt (KW) over the full range of operation.

c. Prototype blower pressure-volume-horsepower performance curves at 68 degrees Fahrenheit (F).

d. Material list and catalog information showing the details of blower construction.

e. Outline installation drawings for each unit.

f. List of recommended spare parts for 5 years of operation.

3. Motor characteristics, specifications and performance.

a. Descriptive bulletins

b. Outline drawings with dimensions

c. Nameplate data

d. Description of insulation system

e. Service factor

f. Efficiency at 50 percent, 75 percent and 100 percent of full load

g. Special features including condensation heaters and winding temperature detectors

h. Motor data as required by Section 26 05 84

4. Shop Drawings: Submit signed and sealed structural calculations by a Professional Engineer registered in the State of Oregon and detailed drawings for the attachments and anchorage to the structure of the equipment and appurtenances in this section.

5. Submit certification from the manufacturer that the equipment is capable of resisting seismic loads.

6. Elementary and connecting wiring diagrams showing external connections to other equipment.

C. Shop Drawings

1. Certified dimensional drawings of the blower unit, including cutaways and exploded views.

2. Instrumentation and control system schematics, tubing and conduit details, and wiring diagrams for electrical and control components.

3. Certified drawings of the vendor supplied panel(s).

D. Quality Control

1. Reports shall be organized and clearly present testing methods and procedures, testing equipment, test data, calculations and analyses, conclusions, and recommendations. Submit four copies of each certified non-witnessed factory performance test results for favorable review by the Owner and Engineer prior to jobsite shipping.

2. If certified factory test reports indicate noncompliance with the requirements of the Contract Documents, deficiencies shall be corrected at the factory and the blowers shall be re-tested until compliance with the Contract Documents is attained.

3. Certified Factory Test Results shall include:

a. Certified acoustical test results for each blower package.

b. Certified hydrostatic test results for each blower.

c. Certified report of dynamic balancing and maximum vibration amplitude.

E. Manuals: Furnish manufacturer's installation, lubrication, operation and maintenance manuals, bulletins, and spare parts lists. Include the following manual submittals:

1. Provide record drawings showing as-built dimensions, as-built wiring and control diagrams, as-built logic diagrams, and design information for supplied parts and equipment.

2. Provide a detailed control system description.

3. Provide panel drawings, wiring diagrams, specifications, and a detailed description of the Vendor's Control Panel.

4. Provide a copy of the software ladder logic covering all logic and sequences of operation. Provide a soft copy of all documents and programmable logic controller (PLC) code on CD. Provide a list of instrument settings.

5. Provide input/output (I/O) listings for all control panel PLCs.

6. Indicate all scheduled maintenance requirements and routine inspections.

7. Provide the local sales representative contact information with the company name, contact person, phone number, and address.

F. Affidavits: Submit affidavits from the manufacturer stating that the equipment has been properly installed, adjusted and tested, and is ready for full time operation.

1.4 QUALITY ASSURANCE

A. All equipment furnished under this Section shall: 1) be of a manufacturer who has been regularly engaged in the design and manufacture of the equipment for at least 5 years; and 2) be demonstrated to the satisfaction of the Engineer that the quality is equal to equipment made by those manufacturers specifically named herein.

1.5 WARRANTY

A. Provide a 2-year warranty from the date of initial operation covering all defects in material and workmanship under the specified operating conditions. Warranty to include parts, labor, and cost of travel of manufacturer's technician.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Blowers specified herein shall be Aerzen, Kaeser, Universal Blower Pac, or equal.

2.2 EQUIPMENT

A. Blower Schedule: The blower operating characteristics shall be as follows:

Equipment Name	Aeration Blowers 1 &2	Aeration Blowers 3 &4
Equipment Number	BLO-440-01 BLO-440-02	BLO-440-03 BLO-440-04
Design Inlet Temperature	95 °F	95 °F
Design Inlet Pressure	14.3 psia	14.3 psia
Design Relative Humidity (%)	80%	80%
Free Field Noise Guarantee	80 dB(A) at 3 feet (at design point)	80 dB(A) at 3 feet (at design point)
Design Flow	1200 scfm	2200 scfm
Minimum Turndown (VFD ONLY)	300 scfm	550 scfm
Design Discharge Pressure	5.6 psi	5.75 psi
Brake Horsepower (Max)	50 HP	100 HP
Discharge Flange (inch)	6-inch	10-inch
Basis of Design	Aerzen D52S	Aerzen D475L

Notes:
(a) Package BHP to include pressure loss through a dirty inlet filter/ silencer, pressure loss of the exhaust silencer and check valve.
(b) Package Performance shall be guaranteed to ISO 1217 with a tolerance is +/- 5% on volume flow and +/- 5% on package horsepower.
(c) Sound data shall be from an ISO 2151 method of measurement, in an ISO 3745 qualified test facility. Sound data shall be compliant with a Declaration of Conformity assessment standard.

B. Manufacturer shall guarantee that the blower shall provide oil-free operation and be certified to ISO 8573-1 Class Zero.

C. Blower shall have one power feed to the main drive motor and one power feed to the blower control panel. Any other power feeds are not acceptable.

D. Blower Casing:

1. The casing shall be of one-piece construction, with separate side plates that are bolted and pinned to the housing.
2. Casing materials shall be close-grained cast iron ASTM A48 suitably ribbed to prevent distortion under the specified operating conditions.
3. Inlet and outlet shall be flanged connections, not threaded.
4. The vibration level as measured at the casing, in the X/Y planes of the bearings, shall not exceed 0.3 inches per second root-mean-square (RMS) when operating at the specified operating pressure and speed. The vibration level shall be checked at start- up and documented in the field start up report.

E. Factory Testing:

1. Each rotary lobe blower shall be factory performance tested in accordance with ISO 1217 standards to verify flow and brake horsepower. A slip test shall not be acceptable.

2. The acceptance criteria are +5 percent tolerance on power and -5 percent tolerance on flow regardless of the size of the machine.

F. Rotors:

1. Each rotor (male and female) shall be of the "stiff' design with first lateral critical speed at least 120 percent of the maximum allowable operating speed.

2. The rotors shall operate without rubbing nor shall they require lubrication.

3. Rotors shall be drop forged in one single piece of AISI 1043 or equivalent.

4. Open rotors are not acceptable.

5. Rotors shall be statically and dynamically balanced per ISO1940/ANSI S2.19 G2.5.

G. Bearings:

1. Each impeller/shaft shall be supported by anti-friction bearings and fixed to control the axial location of the impeller/shaft in the unit.

2. Regardless of theoretical bearing life calculations, the bearings shall be sized for a minimum expected life of 5 years between overhauls.

H. Timing Gears:

1. The impellers shall be timed by a pair of single helical gears with quality equivalent to AGMA 12.

2. Gears shall have hardened and ground teeth and a minimum AGMA service factor of 1.70.

3. Gears shall be mounted via hydraulic expansion onto the shafts with a tapered interference fit and secured by a locknut.

I. Seals:

1. Seals shall be designed to prevent lubricant from leaking into the air stream as well as to prevent oil from leaking out of the machine.

2. The seal shall consist of two rotary slip rings mounted in a retainer with an atmospheric air gap in the center.

3. The rotor shaft shall be protected by a shaft sleeve.

4. An O-ring shall be provided under the shaft sleeve to prevent oil migration along the shaft into the air conveying chamber.

J. Lubrication:

1. The timing gears and the bearings shall be oil lubricated. Grease lubrication shall be not acceptable.

K. Oil Sight Glass:

1. An oil sight glass shall be provided on the exterior of the noise enclosure so the operator can easily view the oil level.

2. Sight glasses inside the enclosure or that cannot be easily viewed by the operator shall not be acceptable.

L. Painting:

1. Painting shall be per supplier's standard meeting the following criteria:

   a. Except for machined sealing and machined mounting surfaces, the package shall be painted dark blue.

   b. Aluminum, stainless steel, and brass shall not be painted.

   c. The supplied motor shall not be over sprayed and will be supplied with the motor manufacturer's standard protection and paint color.

   d. Painted Cast Iron and Carbon Steel shall be Alkyd Resin Primer and Final coat with a total dry film thickness of 70-mil. Surface preparation SSPC10 or better.

   e. Sound enclosure shall be powder-coated polyester base total dry film thickness 80-mil.

   f. Galvanized components shall only be painted with appropriate surface preparation

M. Inlet Filter/ Silencer:

1. Each package shall be supplied with one combination inlet filter and silencer.

2. The inlet filter silencer shall be mounted directly to the inlet flange of the blower on the inside of the blower enclosure.

3. The filter media efficiency shall meet the requirements of ASHRAE 52.2 MERV7 50-70 percent at 3-10 microns corresponding to EN779 G4.

4. The silencer portion shall be located upstream of the inlet filter.

5. The filter element shall be designed to trap dirt on the inside so that upon changing, dirt does not fall into the machinery.

6. Filter and silencer performance losses (clean element) shall be included in the entire package performance calculation.

N. Base Frame I Discharge Silencer:

1. Each package shall be supplied with one combination base frame/discharge silencer.

2. The silencer shall be a chamber type design for maximum sound attenuation and shall not use internally any absorption materials of any kind (fibrous or otherwise).

3. The silencer shall be fabricated of a single shell of pressure vessel quality steel with continuous welds.

4. The silencer must be subject to a pressure test for tightness and strength at a minimum of 1.65 times the maximum design pressure.

5. The silencer shall have a machined flanged inlet connection and bolt directly to the discharge flange of the blower, with no intermediary or interconnecting pieces.

6. Insulation shall be provided surrounding the discharge silencer to reduce the heat loss within the sound enclosure and keep the air temperature at the inlet of the blower as low as possible, therefore, contributing to high compression efficiency.

7. Discharge silencer performance losses shall be included in the entire package pressure calculation.

8. The base frame shall be constructed from welded carbon steel that shall be designed to maintain alignment of the blower internal components and the drive during operation.

9. The base frame shall be designed to resist distortion while being installed on vibration isolating mounts.

10. The manufacturer shall supply a stainless steel grounding lug fully welded to the base.

O. Flexible Connectors:

1. Each package shall be provided with a flexible ANSI style discharge connector

2. Flexible connectors shall prevent the transmission of noise and vibrations from the blower package into the piping.

3. Flexible discharge connectors shall be Proco Style S111, with a standard ANSI flange connection.

P. Electric Motor:

1. Each package shall be supplied with a WEG manufactured totally enclosed, fan cooled (TEFC) The National Electrical Manufacturer's Association (NEMA) Premium Efficiency motor that shall operate on 460 Volts, 3 Phase, 60 Hertz current, 3600 revolutions per minute (RPM).

2. Motors shall be horizontal, foot mounted, rigid base, Torque NEMA B, Temperature rise Class B, TEFC IP55, watertight, and dust tight enclosure.

3. Class F, inverter rated insulation, 3:1 constant torque variable frequency drive (VFD)-duty.

4. All frame sizes shall be NEMA standard, suitable for overhung belt drive and with the conduit box on top of the motor. The International Electrical Commission (IEC) frame motors shall not be allowed.

5. The motor will be mounted on a pivoting base to provide automatic tensioning of the belts. The motor nominal rating after any corrections for ambient conditions shall be 10 percent above the maximum operating horsepower.

6. The motor shall have a 1.25 service factor for sizes up to 100 horsepower (HP) and a 1.15 service factor for sizes above 100 HP.

7. Motor windings shall be supplied with a normally closed thermostat, one per phase, wired in series to form a fail-safe motor protection circuit for the external fault circuit of the motor controller on all frame sizes at or above 324T. Thermostat shall be a Klixon Precision Thermostat by Sensata Technologies.

8. Blower manufacturer shall be responsible for coordinating the starting torque requirement of the blower and the motor.

Q. V-Belt Drive:

1. Each package shall be supplied with a V-belt drive that shall be of the high capacity type, oil, and heat resistant.

2. Drive shall be designed for a minimum service factor of 1.4 times operating power (brake horsepower (bHp)), or 1.1 times the motor nameplate HP, whichever is larger to allow a minimum of 1.4-service factor based on the maximum blower bHp.

3. Belt tensioning shall be automatic without the use of any spring devices or interaction on the part of the operator. Slide rails shall not be used as a tensioning device.

4. Sheaves shall be dynamically balanced regardless of the operating speed and hydraulically mounted on the compressor drive shaft.

R. Belt Guard:

1. The belt drive shall be guarded in compliance with Occupational Safety and Health Administration (OSHA) regulations.

2. Portions of the guard shall be easily removable allowing for belt inspection and replacement.

3. Guard material shall be perforated galvanized carbon steel.

S. Vibration Isolators:

1. Each package shall be supplied with vibration isolating feet with a minimum efficiency of 80 percent.

2. The manufacturer shall be responsible for attenuating noise and vibration in the package such that no special installation base shall be required, nor shall any additional measures be required to reduce vibrations from the package being transmitted to the base or the piping.

T. Pressure Safety Valve:

1. Each package shall be supplied with a single pressure safety valve on the discharge side of the blower mounted downstream of the discharge silencer and upstream of the check valve.

2. The safety valve shall be set to protect the machine from exceeding its maximum pressure rating and shall be sized to pass 100 percent of the design flow.

3. The valve shall be field adjustable, spring loaded, and have a certificate of conformity to The Pressure Equipment Directive (PED) if operating above 15 pounds per square inch gauge (psig).

4. The pressure safety valve shall be housed inside and attenuated by the sound enclosure. The safety valve shall relieve hot air into a segmented and sealed section of the sound enclosure so that the hot air cannot reenter the inlet of the machine.

U. Check Valve:

1. Each package shall be supplied with one check valve that shall be installed on the discharge line.

2. The check valve shall be of the full-bore low pressure-drop, flapper type design with a steel body, and steel flap embedded in ethylene propylene diene monomer rubber (EPDM) with full-contact seal.

3. The valve shall be easily removable without disturbing the piping.

4. Pressure losses produced by the check valve shall be included in the entire package performance calculation.

V. Monitoring Sensors

1. Inlet Pressure Transducer

2. Discharge Pressure Transducer

3. PT1000 Discharge Temperature resistance temperature detector (RTD)

4. PT1000 Oil Temperature RTD

W. Blower Control Panel:

1. No control panel shall be provided by the blower manufacturer. Contractor will provide wiring, control at the plant SCADA level.

X. Each blower shall receive its initial oil filling at the factory. Oil to be fully synthetic and rated for 16,000 hours of operation between change intervals.

Y. Acoustical Sound Enclosure:

1. Each package shall be supplied with a sound enclosure covering the entire blower package.

2. The enclosure shall provide suitable protection for outdoor installation under wind loads of 50 miles per hour and snow loads of 25 pounds per square foot.

3. The enclosure shall be designed so as to be able to install them side-by-side with all maintenance done from the front or back of the package.

4. Details shall be as follows:

    a. Enclosure Panels shall be made of galvanized steel sheet, powder coated in a light reflecting, blue color per RAL 5001. The skid shall be of the same color.

    b. Sound enclosure acoustic material shall comply with UL 94 - HF1 for fire-retardant, self-extinguishing, non-dripping materials.

    c. The enclosure and the blower package shall both be mounted on a skid/oil-drip pan designed for meeting environment protection standards and for easy transportation and installation.

    d. A grounding strap shall be installed between the blower base and the package skid to bypass any vibration isolating mounts for grounding continuity.

    e. Quick release panels, each less than 50-pound must provide easy and quick access for routine maintenance of the blower and the package components.

    f. Enclosure Cooling / Ventilation Fan:

        1) Ventilation fan shall be provided for cooling the sound enclosure.

        2) The fan shall be sized for sufficient heat removal from the sound enclosure, even when the blower is operated with a VFD.

        3) The cooling fan shall be driven separately by a 460-volt, 3-phase, 60-hertz electric motor powered by the same 460 VAC electric feed as the blower control panel.

    g. To prevent possible operator damage, electrical components, instrumentation and instrument connections shall not be mounted or interface with moving panels of the sound enclosure.

    h. Both blower oil sumps shall be piped to a common fill and drain, located at the front of the package for easy maintenance. An oil level indicator shall be mounted on the outside of the enclosure, which gives an accurate oil level indication while the blower is in operation. All oil lines shall be industrial-quality hydraulic hose and fittings.

2.3 SPARE PARTS

A. Furnish the following spare parts for each blower package specified:

1. Complete set of matched V-belts

2. One inlet air filter element

3. One oil filter element

B. Spare parts shall be properly bound and labeled for easy identification without opening the packaging.

PART 3 EXECUTION

3.1 INSTALLATION

A. The Contractor shall install the Blowers in strict conformance with the manufacturer's installation instructions and recommendations. Attached piping, valves, and other devices shall be independently supported, and shall not transmit any weight or forces to the blower.

B. The process startup shall be executed in conjunction with the OwnerOwner's personnel to assure the entire aeration system works in harmony and according to the intent of the design.

3.2 FIELD TESTING

A. Field test each complete blower unit:

1. This test shall include a record of at least five test points to establish the pressure-volume characteristics and motor horsepower at the blower's rated speed.

2. Determine horsepower by measuring the kW input to the blower drive motor utilizing the blower manufacturer's calibration curve showing relationship of kW input versus motor output horsepower.

B. Provide third party electrical harmonic mitigation testing of all adjustable-frequency drives (AFDs) associated with the blower system.

C. Test noise level to meet the requirements of these specifications.

D. Submit a complete report including a copy of test data, copy of calculations, pressure, volume and brake horsepower curves, and observations made during the test.

3.3 FIELD SERVICES

A. Conduct field acceptance testing after the installation of all equipment has been completed and all instrumentation calibrated and working as intended and the equipment has operated for a period sufficient to make all necessary operational adjustments. Contractor shall schedule testing with the full knowledge and consent of Owner.

B. The blower manufacturer shall supply a factory-trained field service engineer to thoroughly check and inspect the blowers after installation, place them in operation, make necessary adjustments, calibrate instruments, and conduct field tests. The services required shall also include on-the-job training of operators and maintenance staff on safety procedures and inspections, operating instructions, preventive maintenance procedures and calibration check. The field services engineer shall be on-site for at least two 2-person days of field services.

3.4 OWNER/ENGINEER TRAINING

A. The manufacturer shall provide a minimum of 8 hours of training to the Owner's operations staff.

END OF SECTION

SECTION 43 13 46 – DIGESTER GAS SAFETY EQUIPMENT AND SPECIALTIES

PART 1 GENERAL

1.1 SUMMARY

1.2 RELATED SECTIONS

A. Section 05 50 00 – Metal Fabrication

B. Section 09 90 00 – Painting and Coating

C. Section 46 05 13 - General Requirements for Equipment

1.3 REFERENCE STANDARDS

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

1. American Society of Mechanical Engineers (ASME):

a. B16.1, Gray Iron Pipe Flanges and Flanged Fittings (Classes 25, 125, and 250).

b. B16.5, Pipe Flanges and Flanged Fittings NPS 1/2 through NPS 24 Metric/Inch Standard.

c. Boiler and Pressure Vessel Code (BPVC), Section VIII, Rules for Construction of Pressure Vessels.

2. National Electrical Manufacturers Association (NEMA): 250, Enclosures for Electrical Equipment (1,000 volts, maximum).

1.4 DEFINITIONS

1.5 SUBMITTALS

A. Shop Drawings:

1. Make, model, and weight of each equipment assembly.

2. Manufacturer’s catalog information, descriptive literature, specifications, and identification of materials of construction.

3. Detailed mechanical and electrical drawings showing equipment fabrications and interface with other items. Include dimensions, size, and locations of connections to other work, and weights of associated equipment.

4. [Functional description of internal and external instrumentation and controls to be supplied including list of parameters monitored, controlled, or alarmed.]

5. [Control panel elevation drawings showing construction and placement of operator interface devices and other elements.]

6. Power and control wiring diagrams, including terminals and numbers.

7. Shop and Field Painting Systems Proposed: Include manufacturer's descriptive technical catalog literature and specifications.

8. Seismic anchorage and bracing drawings and cut sheets, as required by Section 01 88 15, Anchorage and Bracing.

B. Quality Control Submittals:

1. Seismic anchorage and bracing calculations as required by Section 01 88 15, Anchorage and Bracing.

2. Special shipping, storage and protection, and handling instructions.

3. Manufacturer's written/printed installation instructions.

4. [Routine maintenance requirements prior to plant startup.]

5. [Factory] [and] [field] performance test procedures.

6. Component and attachment testing seismic certificate of compliance as required by Section 01 45 33, Special Inspection [, Observation,] and Testing.

7. Operation and Maintenance Data: As specified in Section 01 78 23, Operation and Maintenance Data.

8. Manufacturer's Certificate of Proper Installation, in accordance with Section [01 43 33, Manufacturers' Field Services] [________].

9. [Service records for maintenance performed during construction.]

1.6 QUALITY ASSURANCE

1.7 SPARE PARTS

A. Furnish, tag, and box for shipment and storage the following materials:

Item	Quantity
Automatic Drip Trap: Gaskets	[Three] [________] complete sets

Item	Quantity
Manual Drip Traps: Gaskets and O-rings	[Three] [________] complete sets
[________]	[One] [________] complete set [per unit]

B. Delivery: [In accordance with Section 01 61 00, Common Product Requirements.] [________]

1.8 WARRANTY

A. Manufacturer shall warrant the equipment to be free from defects in material and workmanship for a period of 12 months from startup or 18 months from shipment, whichever is earlier.

PART 2 PRODUCTS

2.1 MANUFACTURERS:

1. Groth
2. Varec

2.2 SERVICE CONDITIONS

A. Material Handled: Digester gas consisting of approximately [61] [________] percent methane, [33] [________] percent carbon dioxide, [5] [________] percent water vapor, and [1] [________] percent hydrogen sulfide. Specific gravity approximately [0.86] [________].

2.3 PERFORMANCE REQUIREMENT

2.4 COMPONENTS

A. WASTE GAS BURNER/IGNITION SYSTEM

1. General:

a. Capacity: [____4,000____] standard cubic feet per hour water column (WC) digester gas at maximum pressure drop of [____1/2____] -inch WC. Digester gas will have a minimum heat content of [550] [________] British thermal unit (Btu) per cubic foot and will be saturated with water at [90] [____90____] degrees Fahrenheit (F).

b. Size: [6] [______2___] inches [, with [1/2] [3/4] -inch pilot line].

c. Pilot Fuel: [Digester] [Natural] gas.

2. Waste Gas Burner:

a. Materials:

1) Type 316 stainless steel for pilot nozzles, piping, and fittings.

2) Integral Type 304 stainless steel shroud of 10-gauge minimum thickness.

b. [6] [___2______] -inch flanged digester gas connection.

c. Self-supporting, mounted vertically on a matching ASME B16.1 150-pound raised face flange.

d. Integral [2] [______2___] -inch continuous burning pilot and [1/2] [___1/2______] -inch flame retention pilot.

e. Furnish with 1/2-inch-thick, Type 316 stainless steel thermowell housing, 1/4-inch magnesium filled Incoloy 600 sheath Type K thermocouple mounted in the continuous pilot nozzle.

3. Ignition System:

a. Venturi: 2-inch NPT, aspirating, to supply a combustible air/gas mixture to the continuous flame nozzle.

1) Include a combustion chamber, spark plug, and flashback preventer.

2) Furnish 1/2-inch NPT inlet connection.

b. Regulator Assembly: Valve and regulator package to provide pressure reduction and isolation of pilot gas as required.

1) Consist of isolation valves, pressure regulators, pressure gauges, explosion-proof solenoid valve, and interconnecting fittings.

2) Components shall be copper free and affixed to a backplate.

c. To ignite waste gas burner pilot flame, the following shall occur in sequence:

1) Pilot gas solenoid valve and flame retention solenoid valve shall be commanded to OPEN.

2) A spark shall be generated to ignite air/gas mixture at exit of venturi assembly.

3) Flame generated by spark ignites gas exiting from flame retention nozzle.

4) When thermocouple located inside the continuous flame nozzle heats up to a preset temperature setting, flame retention solenoid valve shall be commanded to CLOSE.

5) Pilot flame remains lit using air/gas mixture supplied by the continuous flame nozzle.

6) If pilot flame goes out, a re-ignition cycle will automatically be initiated.

d. If pilot flame is lit and LOW temperature is detected by pilot thermocouple, a BURNER SYSTEM FAIL output shall be provided. A discrete output shall also be provided for remote indication of pilot FLAME ON.

e. Power Requirements: Power supply to control panel shall be 120-volt alternating current (ac), single-phase, 60 Hertz (Hz).

1. Controls: In accordance with general control requirements and component qualities specified [in Section 40 99 90, Package Control Systems] [below] [_________]. Provide panels and controls as follows:

Panel No.	Name	NEMA 250 Rating	Material
		4X	316 stainless steel
		4X	316 stainless steel
		4X	316 stainless steel

1) Operator Controls and Indicators:

2) STANDBY/AUTO/MANUAL control of waste gas burner.

3) IGNITION pushbutton to generate spark for burner in MANUAL mode.

4) Spark ON, flame retention solenoid valve OPEN, pilot ON, and pilot OFF indicating lights mounted inside of panel.

5) Control power ON/OFF switch mounted inside panel.

6) AUTO START simulator switch mounted inside panel.

b. External Interfaces:

1) Burner system FAIL discrete output.

2) Flame ON discrete output.

3) START discrete input to start pilot.

4) Discrete outputs shall be SPDT contacts rated for 2 amperes (amps) continuous at 120 volts ac, minimum.

c. Functional Requirements:

1) Provide STANDBY/AUTO/MANUAL control of pilot flame for waste gas burner. In STANDBY mode, pilot gas supply shall be shut off and pilot ignition system shall be disabled. In MANUAL mode, pilot gas supply shall be turned on and pilot flame shall be manually ignited by IGNITION pushbutton.

2) In AUTO mode, pilot flame shall be automatically ignited and extinguished depending upon the availability of waste gas, as sensed by a pressure switch on waste gas inlet. When sufficient pressure exists at waste gas inlet, pilot shall be automatically ignited, after an adjustable time delay. When pressure at waste gas inlet falls below pressure setpoint, pilot shall be extinguished after an adjustable time delay. To assist in startup and troubleshooting, AUTO ignition system and AUTO-START simulator switch shall be provided.

2. Secondary Stack: Secondary stack and support fabricated from [corrosion-resistant, high-chrome nickel] steel. Secondary stack size and details shall be confirmed by manufacturer of waste gas burner.

B. SEDIMENT TRAPS

1. Features:

a. Materials: [Carbon steel.] [Stainless steel.]

b. [One] [____One____] [6] [8] [____4____] -inch size.

c. Flow Capacity: [21,000] [____42,000____] standard cubic feet per hour at 1/2-inch WC maximum pressure drop.

d. Storage Capacity: [6] [____12____] gallons of accumulated sediment and condensate, minimum per unit.

e. Convenient access to interior of unit without requiring its removal from operating position.

f. [1-inch] [____1”____] connection for drip traps and 2-inch drain connections.

2. Manufacturers and Products:

a. Groth; Model 8330 with sight gauge. Orientation of sight glasses and traps may be nonstandard.

C. MANUAL DRIP TRAPS

1. Design to prevent gas from escaping while draining.

2. Capacity: [2-1/2 quarts] [____3 quart____] with [5 pounds per square inch gauge] [____5 psi____] working pressure.

3. Construction: 356 heat treated (HT) aluminum body, handles, neoprene O-ring, Type 316 stainless steel internals.

4. Manufacturers and Products:

a. Groth; Model [8460] [________].

D. PRESSURE RELIEF VALVE WITH FLAME TRAP ASSEMBLY

1. Size: [6] [____2”_and 4”___] inches [minimum].

2. Capacity: [____1,000____] standard cubic feet per hour for 2” and 4,000 standard cubic feet per hour for 4” at 1/2-inch WC above relief setting.

3. Location: One on each digester gas train and one upstream of waste gas burner.

4. Pressure Relief Setting: [____12”____] -inch WC [, with extra weights to allow field adjustment of setting].

5. Settings: Furnish valves with weights to allow field adjustment of the set pressure.

a. Each Valve: Adjustable over a range of 3-inch WC below and 3-inch WC above the pressure relief setting in 1-inch increments.

Valve	Pressure Relief Setting	Vacuum Relief Setting

6. [Pressure/Vacuum Relief Valve and Flame Arrestor: Separate units with valve factory mounted on top of arrestor.]

7. Flame Arrestor Bank Assembly: [Separate unit] easily removable without disconnecting unit.

8. [Relief Valve Pallet Seat Inserts: Teflon.]

9. Provide "all weather" features to protect valve operation in temperatures ranging from minus 25 degrees F to 200 degrees F. Include the following:

   a. Special antifreeze coating applied to seat ring tip.

   b. Pallet periphery and stem.

   c. Guideposts.

10. Insulation:

    a. Insulating jackets with 1-inch-thick, 6-pound density fiberglass insulating material and silicone impregnated woven glass cloth lining.

    b. Through-cover quilting pins for firm support of insulation.

    c. Attach insulation jackets to units with a combination of Velcro and cinch belts.

11. Manufacturers and Products:

    a. Groth; Model 8400

E. PRESSURE/VACUUM RELIEF VALVE WITH FLAME ARRESTOR

1. Size: [6] [____6"___] inches [minimum].

2. Capacity: [___24_____] standard cubic feet per hour at 1-inch WC above relief setting and [___19.8_____] standard cubic feet per hour minimum at [1] [____1____]-inch WC below vacuum relief setting].

3. Location: Two on each new digester cover.

4. Pressure Relief Setting: [____10____] -inch WC [, vacuum relief setting [________] -inch WC below atmospheric pressure] [, with extra weights to allow field adjustment of setting].

5. Settings: Furnish valves with weights to allow field adjustment of the set pressure.

a. Each Valve: Adjustable over a range of 3-inch WC below and 3-inch WC above the pressure relief setting in 1-inch increments. Adjustability in the vacuum relief setting is not required.

Valve	Pressure Relief Setting	Vacuum Relief Setting

6. [Pressure/Vacuum Relief Valve and Flame Arrestor: Separate units with valve factory mounted on top of arrestor.]

7. Flame Arrestor Bank Assembly: [Separate unit] easily removable without disconnecting unit.

8. [Relief Valve Pallet Seat Inserts: Teflon.]

9. Provide “all weather” features to protect valve operation in temperatures ranging from minus 25 degrees F to 200 degrees F. Include the following:

   a. Special antifreeze coating applied to seat ring tip.

   b. Pallet periphery and stem.

   c. Guideposts.

10. Insulation:

    a. Insulating jackets with 1-inch-thick, 6-pound density fiberglass insulating material and silicone impregnated woven glass cloth lining.

    b. Through-cover quilting pins for firm support of insulation.

    c. Attach insulation jackets to units with a combination of Velcro and cinch belts.

11. Manufacturers and Products:

    a. Groth; Model 8400

F. SAFETY SELECTOR VALVE

1. Provide each digester with one safety selector valve for mounting pressure/vacuum relief valves with flame arrestors.

2. Size: [inch(es)], three-way type.

3. Construction: Aluminum body with stainless steel internals and Teflon gaskets and seals.

4. Rating: 150-pound with ASME B16.5 flanged connections.

5. Provide insulating jackets per Article Pressure/Vacuum Relief Valve with Flame Arrestor.

6. Manufacturer and Product:

   a. Groth: Model 8800

G. DIGESTER MANHOLE COVERS

1. [____30____] -inch diameter non-sparking, gastight, hinged cast-iron, flanged manhole covers, with multiple-hinged hold-down lugs and tallow impregnated flax gasket insert in cover. [Each cover shall have a 3/4-inch NPT tapped and plugged hole.]

2. Manufacturers and Products:

   a. Groth; [Model 8200] [________].

H. DIGESTER SAMPLING PORT COVERS

1. [____6____] -inch diameter.

2. [Aluminum] [construction, [synthetic rubber gasket] [non-sparking construction].

3. Manufacturers and Products:

   a. Groth; Model 6100.

2.5 ACCESSORIES

A. Lifting Lugs: Provide suitably attached for equipment assemblies and components weighing over 100 pounds.

B. Equipment Anchor Bolts: Type 316 stainless steel sized by equipment manufacturer at least 1/2-inch in diameter, or as shown, and as specified in Section 05 50 00, Metal Fabrications.

C. Equipment Identification Plates: Provide 16-gauge Type 304 stainless steel identification plate securely mounted on each separate equipment component in a readily visible location. Plate shall bear 3/8-inch high engraved black enamel filled equipment identification number indicated in this Specification.

2.6 FACTORY FINISHING

A. For carbon steel and cast-iron equipment and accessories, factory prepare, prime, and finish paint with manufacturer's standard coating as specified in Section 09 90 00, Painting and Coating, for exposed or high temperature surfaces.

2.7 SOURCE QUALITY CONTROL

PART 3 EXECUTION

3.1 INSTALLATION

A. In accordance with manufacturer's instructions.

B. Accurately place anchor bolts using templates furnished by manufacturer and in accordance with Section 05 50 00, Metal Fabrications.

3.2 FIELD QUALITY CONTROL

A. Functional Test: Conduct on each unit.

3.3 PERFORMANCE TESTING AND STARTUP

3.4 MANUFACTURER'S SERVICES

A. Manufacturer's Representative: Present at Site or classroom for minimum person-days listed below, travel time excluded:

1. [____1____] person-days for [installation assistance] [and] [inspection].
2. [____1____] person-days for [functional] testing and completion of Manufacturer's Certificate of Proper Installation.
3. [____1____] person-days for pre-startup classroom or Site training.
4. [____1____] person-days for facility startup.
5. [____1____] person-days for post-startup training [of Owner's personnel]. [Training shall not commence until an accepted detailed lesson plan for each training activity has been reviewed by [] [Engineer]

END OF SECTION

SECTION 43 21 52 –VERTICAL TURBINE PUMPS

PART 1 GENERAL

1.1 SUMMARY

The contractor shall provide all equipment labor and materials to furnish and install the 480-Volt, 3-Phase, 60-Hertz Vertical Turbine Utility Water Pump. Motor, Column Pipe, and Accessories, as shown on the drawings and required by these specifications. Pump Supplier shall unit responsibility for all equipment listed in this section.

1.2 SUBMITTALS

A. Shop drawing submittals in accordance with 01 33 00 - Submittal Procedures.

B. Name of nearest location of permanent parts supply from which parts may be obtained in sufficient quantity on a 24-hour basis.

C. Four copies of operating and maintenance manuals shall be supplied.

D. Manufacturer's warranty.

E. Results of a N/W Performance Test conducted at the Factory, test results must be approved by engineer prior to shipment of equipment. Five hydraulic points must be taken, each point will show the horsepower, amperage, flow, head and net positive suction head required (NPSHR). Results will be stamped by a licensed engineer who works for the pump manufacture, results will be sent to design engineer for approval prior to shipment from the factory.

F. Results for a N/W Factory Hydro Test will be performed on the Discharge Head, the test will be conducted to show the Discharge Head is built for 150 percent of Shut-off Head Conditions. Test Results will be stamped by a licensed engineer and provided to the design engineer for approval prior to shipment.

1.3 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

Pumps shall meet the requirements of the latest version of ANSI/AWWA E-101, Vertical Turbine Pumps – Line Shaft and Submersible Types and the Hydraulic Institute Standards, except where modified herein.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Goulds

B. Peerless

C. Flowserve

D. or approved equal

2.2 EQUIPMENT TAG NUMBER

PUMP NAME	UTILITY WATER PUMP 1	UTILITY WATER PUMP 2
PUMP TAG NUMBER	PMP-810-01	PMP-810-02

2.3 CONDITIONS

A.	Duty	Continuous
B.	Ambient Temperature (F)	55 to 105
C.	Fluid Service	Secondary Effluent
D.	Fluid Temperature (F)	40 to 70
E.	Fluid PH	6 to 8
F.	Project Site Elevation (ft)	519

2.4 PERFORMANCE REQUIREMENTS

A.	Design Flow (gpm)	274
B.	Design Head (TDH ft)	236
C.	Maximum Shut of Head (ft)	301
D.	Minimum Design Bowl Efficiency (%)	80.8
E.	Maximum Pump Motor Speed (RPM)	1770
F.	Motor HP Rating	25
G.	Minimum Number of Bowl Stages	6

2.5 EQUIPMENT DIMENSIONS

A.	Impeller Trim (inches)	6.5625
B.	Discharge Size (inches)	6
C.	Minimum Column Diameter	9
D.	Water or Oil Lubricated	Water
E.	Minimum Line-Shaft Diameter	1.5
F.	Pump Bowl Elevation (ft)	509
G.	Water Surface Elevation (ft)	509

2.6 PUMP CONSTRUCTION

A. The bowls shall be flanged type constructed of close-grained cast iron conform to ASTM A48, class 30. They shall be free from sand holes, blowholes, or other faults and must be accurately machined and fitted to close tolerances. They shall be capable of withstanding a hydrostatic pressure equal to twice the pressure at rated flow or 1.5 times shut-off head, whichever is greater. The intermediate bowls shall have enamel or epoxy lined waterways for maximum efficiency and wear protection. All intermediate bowls shall be of identical design for interchangeability. All the bowls shall be fitted with sleeve type bearings of bronze alloy C89835. All wetted parts shall be coated with Tenemic, Pota Pox, or Scotchkote 134 with a total thickness of 12 mils.

B. The impellers shall be constructed from ASTM B584 Silicon Bronze and shall be the enclosed type. They shall be free from defects and must be accurately cast, machined, and filed for optimum performance and minimum vibration. Impellers shall be statically and dynamically balanced at the factory to grade G6.3 of ISO 1940 as minimum. They shall be securely fastened to the bowl shaft with taper locks 416 SS (or key and split thrust ring of SS).

C. The suction bowl or suction bell shall be provided with non-soluble grease packed bronze bearing. Bowl Bearings will be constructed of steel back rubber. A bronze sand collar shall be provided to protect this bearing from abrasives in the pumping fluids. The bearing housing shall have sufficient opening at the bottom for easy removal of the bearing. A galvanized strainer will be provided. It shall have a net inlet area equal to at least three times the impeller inlet area. The maximum opening shall not be more than 75 percent of the maximum opening of the water passage through the bowl or impeller.

D. The bowl shaft shall be constructed from ASTM 582 type 416 stainless steel. It shall be precision ground and polished with surface finish better than 40 root mean square (RMS).

2.7 COLUMN ASSEMBLY

A. The column pipe shall be furnished in sections not exceeding a nominal length of 10 feet and shall be connected by threaded-sleeve couplings. Pump speeds between 2200 revolutions per minute (RPM) and 3600 RPM shall have intermediate column length and bearing spacing no greater than 5 feet. The length of the top and bottom sections shall not be more than 5 feet. The pipes shall be of ASTM A53 grade B steel pipe and the weight shall be not less than schedule 40. The end of the pipe shall be with eight threads per inch with 3/16-inch taper per foot thread and faced parallel to butt against the centering spiders of ASTM B584 Silicon Bronze to form accurate alignment. The inside diameter of the pipe shall be such that the head losses shall not be more than 5 feet per 100 feet of pipe.

B. The line shaft shall be C1045 steel ground and polished with surface finish not to exceed 40 RMS. They shall be furnished in interchangeable sections not over 10 feet in length and shall be coupled with threaded couplings (up to 2-15/16-inch diameter) machined from solid steel bar. It shall have left-hand thread to tighten during pump operation. The diameter of the shaft and coupling shall be designed in according with

AWWA E101 Standard. Each joint shall be equipped with a 304 SS Sleeve; each sleeve will be placed between the bearing and the shafting bearing shall be fluted rubber retained in the centering spider by a shoulder on each end of the bearing.

2.8 DISCHARGE HEAD ASSEMBLY

A. It shall be of the high-profile type to allow shaft coupled above stuffing box and provided for mounting the driver and support the column and bowl assemblies. It shall be fabricated steel. The above ground outlet shall be flanged with a diameter per the contract drawings. The flanged shall be American National Standards Institute (ANSI) class 150 (for steel). It shall have a 1/2-inch National Pipe Thread (NPT) connection for a pressure gauge. The stuffing box shall be cast iron and shall contain five rings of packing manufactured by John Crane. Discharge Head will be provided with a soleplate with a minimum thickness of 1.5 inches; soleplate will be hot dipped and galvanized.

2.9 MOTORS

Each pump shall be provided with a vertically mounted electric motor that conforms to the following requirements and the specifications in Division 26. In the event of conflicts, the more restrictive specification shall apply. The brake horsepower required by the driven equipment anywhere on the pump curve shall not exceed the rated nameplate horsepower of the motor. The ratings indicated are minimums. Motors shall be designed to accept the total, unbalanced thrusts imposed by the pump.

The motor shall be a heavy-duty squirrel cage induction type, NEMA Class B or Class F insulation with WP-1 enclosure, Premium Efficient, Inverter Duty, 1800 RPM vertical hollow shaft motor, with a non-reverse ratchet (or self-release coupling) to prevent reverse rotation of the rotating elements. A thrust bearing of ample capacity to carry the weight of all rotating parts plus the maximum hydraulic thrust load under all conditions of operation calculated L10 life shall be no less than 8800 hours. Provision shall be made for momentary up thrust equal to 30 percent of the rated down thrust. The motor shall be standard (or premium) efficiency, 1.15 service factor, and suitable for use on 480-Volt, 3-phase, 60-Hertz electric service. A solid coupling shall be provided at the discharge head for setting the impeller to bowl running clearance.

2.10 WATER LEVEL INDICATING & SOUNDER TUBE

A. The pump column shall be provided with a slotted 1.5-inch polyvinyl chloride (PCV) pipe of sufficient length to extend from the pump soleplate to the top of the bowl assembly to serve as housing for a pressure transducer. The conduit shall be securely fastened with Type 316 stainless steel straps to the column pipe and care shall be exercised in lowering the pump assembly so that the conduit is not damaged.

B. The pump column shall be provided with nominal 1-inch diameter PVC or high-density polyethylene (HDPE) pipe of sufficient length to extend from the pump soleplate to the top of the bowl assembly to serve as a water level sounding tube. The conduit shall be securely fastened with Type 316 stainless steel straps to the column pipe and care shall be exercised in lowering the pump assembly so that the conduit is not damaged.

2.11 SPARE PARTS

A. The pumps shall be provided with the following spare parts for each pump:

1. Packing gland materials and tools.

PART 3 EXECUTION

3.1 INSTALLATION

A. The pumps shall be installed as specified and in accordance with manufacturer's written recommendations. The installation and initial operation of all components shall be certified on Form as specified in Section .

3.2 TESTING

A. After completion of installation, the pumps shall be completely tested to demonstrate compliance with operating requirements as specified.

B. Field Vibration: Test for acceptable vibration will be made at no additional cost to the owner in the field on each pump system. All field tests will be running tests with the pump pumping product for which it is intended, and each pump system will be tested separately with no other pump running. All tests will be done in the presence of the design engineer. Amplitude as used in this specification will mean peak to peak displacement, the requirements for testing for acceptable vibration will be the measurement of this peak to peak displacement at five separate points on the motor and five separate points on the discharge head.

C. Field Harmonics: During star-up the pump manufacture will perform a Reed Critical Frequency (RCF) analysis commonly referred to as a “bump test”. The bump test will be done through the full operating range of the pump speed, from minimum speed to maximum speed. If there are any reflections of harmonics through the operating range of the pump it will be the pump manufacturer’s responsibility to either correct the problem or inform the owner of the speeds that will need to be avoided through the Variable Frequency Drive Settings. A full report of these findings will be provided to the owner before final acceptance of the equipment.

3.3 MANUFACTURES SERVICES

A. Pumping equipment shall be installed in accordance with approved procedures submitted with the shop drawings and as shown, unless otherwise approved by the

Engineer. Submittals shall be provided to Engineer for all pump components and approved by Engineer prior to ordering and constructing the equipment.

B. A factory Certified Representative of the pump manufacture with no less than 5 years' experience shall be on site for a minimum of two 8-hour days. The representative shall supervise the installation of the pumping equipment

C. A factory Certified Representative of the pump manufacture with no less than 5 years' experience shall be on site for a minimum of one 8-hour day. The representative shall provide start-up and training of owner personnel.

D. The Engineer may require that the inspection, startup, and field adjustment services above be furnished in separate trips.

END OF SECTION

SECTION 43 23 57 – PROGRESSING CAVITY PUMPS

PART 1 GENERAL

1.1 SUMMARY

A. This section includes positive displacement progressing cavity pumps, complete with electric motors, and all specified appurtenances, as shown on the plans and specified herein.

B. The pumping units shall be of the self-priming, positive displacement, progressing cavity type specifically designed for pumping bulk liquid or polymer solutions, as specified and/or wastewater sludge.

1.2 REFERENCES

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

Reference	Title
AGMA 6010-E-88	Spur, Helical, Herringbone, and Bevel Enclosed Drive
AGMA 6019-E-89	Gear Motors Using Spur, Helical, Herringbone, Straight Bevel, or Spiral Bevel Gears
AGMA 6023-A88	Design Manual for Enclosed Epicyclic Gear Drives

1.3 ENVIRONMENTAL CONDITIONS

A. Pumps to be provided under this section will be installed in the Primary Sludge PS Building and the Solids Building. Environmental conditions are as described in Section 23 00 00 .

1.4 SUBMITTALS

A. The following information shall be provided in accordance with Section 01 33 00.

1. Manufacturer's data including materials of construction and equipment weight.

2. Predicted performance curves developed for the specific application. Performance curves shall plot speed, capacity, head, and horsepower required for the specified operating range.

3. Motor data as specified in Section 26 05 84.

4. Universal joint warranty.

5. A copy of this specification section with addenda updates, and all referenced sections with addenda updates, with each paragraph check marked to show specification compliance or marked to show deviations.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Seepex Series BN
B. Moyno
C. Approved equal

2.2 OPERATING CONDITIONS

Equipment Name	Primary Sludge Pump	Dewatering Feed Pump
Equipment Number	PMP-320-01 PMP-320-02	PMP-730-03 PMP-730-04
Sludge type	Municipal Primary Sludge	Digested Sludge
Sludge solids content	4% - 6%	2.5% - 5%
Sludge specific gravity	1.02	1.01
Sludge Viscosity		
Solids size	< 3 in	< 3 in
Sludge temperature	40° F	95° F
Rated capacity, USgpm	40	70
Flow range, USgpm	NA	50-90
Maximum pump speed, rpm	400	400
Minimum pump speed, rpm	100	100
Differential pressure, psi	2.5	28
Minimum motor, hp	5	7.5
Motor with VFD?	NO	YES

2.3 PERFORMANCE AND DESIGN REQUIREMENTS

A. The pumps shall be of the compact, close-coupled design. The gear reducer shall be sized for a minimum service factor of 1.5 and designed with a thrust load capability of 150 percent of the actual thrust load.

B. The pumps, along with associated drive appurtenances, shall be mounted on common fabricated steel baseplates.

C. Manufacturers must currently have installations for the same liquids and of the same model pump unit, in service for a minimum of 3 years. Manufacturers not named in this specification must also provide a pre-submittal package to the engineer no less than 3 weeks prior to the bid date for approval. The pre-submittal package must include, at minimum, the following: dimensional drawing, performance curve, Operations and Maintenance (O&M) manual, electrical/drive details, installation list (for the same liquids as specified) with minimum three contacts and phone numbers.

2.4 MATERIALS

Component	**Material - Sludge Pumps**
Rotor	316ss - Duktil Coated (1250 Vickers hardness)
Stator	Buna N
Pump Body	Cast iron
Shaft Sealing	Burgmann MG1 Q1Q1VGG

2.5 EQUIPMENT

A. ROTOR AND STATOR: Each pump shall be a one (two, four, eight) stage design employing a convoluted rotor operating in a similarly convoluted stator. The convolutions shall be configured to form a cavity between the rotor and stator, which shall progress from the pump's inlet to discharge port with the operation of the rotor. The fit between the rotor and stator at the point of contact shall compress the stator material sufficiently to form a seal and to prevent leakage from the discharge back to the inlet end of the pumping chamber. The stator shall be moulded with a seal integral to the stator elastomer preventing the metal stator tube and the bonding agent from the elastomer from contacting the pumped liquid. Gaskets or "O" rings may not be used to form this seal. Stators for sludge pumps shall have Buna elastomer. The sludge pump rotors shall be constructed of 316 SS. Additionally, the sludge pump rotors shall have a chromium nitride coating (Duktil) with a hardness of 1250 Vickers and a minimum thickness of (.0108-inch).

Hard chrome plating or ceramic coatings are not acceptable due to the ease at which this coating will crack and the lack of diffusion into the rotor base metal.

B. ROTOR AND DRIVE TRAIN: The rotor drive train shall be warranted for 3 years from acceptance and shall consist of the following:

1. Each pump rotor shall be driven through a positively sealed and lubricated pin joint. The pin joint shall have replaceable bushings, constructed of air-hardened tool steel of 57-60 HRc, in the rotor head and coupling rod. The pin shall be constructed of high-speed steel, air hardened to 60-65 HRc. The joint shall be grease lubricated with a high temperature (450 degrees Fahrenheit (F)), polytetrafluoroethylene (PTFE) filled synthetic grease, covered with Buna N sleeve and positively sealed with hose clamps constructed of 304 stainless steel. A stainless steel shell shall cover the rotor side universal joint assembly to protect the elastomer sleeve from being damaged by tramp metals or glass. The universal joints shall carry a separate warranty of 10,000 operating hours. This warranty shall be unconditional in regard to damage or wear.

C. CASING: A 150-pound (American National Standards Institute (ANSI) B16.5) flanged connection shall be provided at both the inlet and discharge ports. The suction and discharge casings shall each be provided with a 3/8-inch (or larger) tap to permit installation of pressure instruments.

D. BEARINGS: Each pump shall be provided with oil lubricated thrust and radial bearings, located in the gearmotor, designed for all loads imposed by the specified service.

E. SHAFT SEALING: Shaft shall be sealed using a single internal mechanical seal as specified in Section 2.02. The shaft shall be solid through the sealing area, but of a two-part design which allows the rotating unit to be removed from the pump without disassembly of the gearmotor bearings. Seal materials shall be solid silicon carbide faces with 316 stainless steel metal parts and Viton elastomers.

F. MOTOR AND DRIVE UNIT:

1. Gear motors or gear reducers shall be designed in accordance with American Gear Manufacturers Association (AGMA) 6019-E (Class II). Unless otherwise noted, motors shall be energy efficient, totally enclosed, fan cooled (TEFC) motors in accordance with Section .

2. Pumps that require variable frequency drives (VFDs) are noted in paragraph 1.01 E. VFDs shall be constant torque type as specified in Section 26 29 23. For VFD-driven units, the pump supplier shall be responsible for the provision of the fixed reduction between the motor and pump. The

reduction ratio shall be that required to operate the pump at its maximum operating speed when the motor is operating at its nominal rated full speed in accordance with the schedule in paragraph 1.01 E. ASD-driven units may be operated at up to 90-hertz at the maximum speed.

2.6 ACCESSORIES:

A. RUN DRY PROTECTION: The stator shall be fitted with a sensor sleeve and thermistor sensor. A controller shall also be provided and shall be installed by the contractor in the motor control center. The controller shall monitor the stator temperature and activate a shutdown and alarm sequence if the stator temperature reaches the adjustable limit on the controller. The controller shall include a manual local and remote reset function. Input to the controller shall be 1x115 volts alternating current (VAC)/60-hertz.

B. OVER PRESSURE PROTECTION: Each pump unit shall be supplied with a silicone-filled isolation ring with a dual mounted gauge and single point pressure switch. The pressure ranges for the switch and gauge shall be selected specifically for each specified service. The isolation ring shall be mounted between ANSI flanges, be sized according to the discharge pipe as shown on the plans and be constructed with a carbon steel body and fittings with a Buna sleeve. The switch shall be single-pole, single-throw (SPDT), NEMA 4.

2.7 SPARE PARTS

A. One set of special tools shall be provided to service the pumps. In addition, the following shall be provided for each pump size (as appropriate for type of drive provided):

1. One – stator assembly with TSE sensor sleeve
2. One – rotor
3. One – set universal joint assemblies

B. Standby components shall be tagged and stored in accordance with provisions of Section .

PART 3 EXECUTION

3.1 INSTALLATION

A. The pumps shall be installed as specified and in accordance with manufacturer's written recommendations.

B. Level base by means of steel wedges (steel plates and steel shims). Wedge taper not greater than 1/4 inch per foot. Use double wedges to provide level bearing surface for pump and driver base. Accomplish wedging so there is no change of level or springing of baseplate when anchor bolts are tightened.

C. Adjust pump assemblies so driving units are properly aligned, plumb and level with driven units and the interconnecting shafts and couplings. Do not compensate for misalignment by use of flexible couplings.

D. After pump and driver ghave been set in position, aligned, and shimmed to proper elevation, grout space between bottom of baseplate and concrete foundation with a poured, nonshrinking grout of the proper category. Remove levelling wedges after grout is set and pack void left with grout.

E. Connect suction and discharge piping without imposing strain to pump flanges.

3.2 TESTING

A. After completion of installation, the pumps shall be completely tested to demonstrate compliance with operating requirements as specified.

END OF SECTION

SECTION 43 23 58 - LOBE PUMPS

PART 1 GENERAL

1.1 SUMMARY

A. This Section includes furnishing, start-up, testing and operation training for pumps that are positive displacement, rotary lobe type, designed to pump wastewater sludge.

B. The equipment furnished shall be designed, constructed, and installed in accordance with the best practice and methods, and shall operate satisfactorily when installed as shown on the Drawings.

1.2 REFERENCES STANDARDS

A. American Bearing Manufacturers’ Association (ABMA).

B. American Iron and Steel Institute (AISI).

C. American National Standards Institute (ANSI).

D. ASTM International (ASTM):

1. A48/A48M, Standard Specification for Gray Iron Castings.

2. D2240, Standard Test Method for Rubber Property—Durometer Hardness.

E. Hydraulic Institute Standards (HIS): 9.6.4, Rotodynamic Pumps for Vibration Analysis and Allowable Values.

F. National Electrical Manufacturers’ Association (NEMA): MG 1, Motors and Generators.

1.3 SUBMITTALS

A. Submit information in accordance with Section 01 33 00.

B. Shop Drawings:

1. Make, model, weight, and horsepower of each equipment assembly.

2. Complete catalog information, descriptive literature, specifications, and identification of materials of construction.

3. Performance data curves showing head, capacity, horsepower demand, and pump efficiency over entire operating range of pump, from shutoff to maximum capacity. Indicate separately the head, capacity, horsepower

demand, overall efficiency, and minimum submergence required at guarantee point.

4. Detailed mechanical drawings showing equipment dimensions, size, and locations of connections and weights of associated equipment.

5. Power and control wiring diagrams, including terminals and numbers.

6. Complete motor nameplate data, as defined by NEMA, motor manufacturer, and including motor modifications.

7. Factory finish system.

8. Seismic anchorage and bracing drawings and cut sheets.

C. Informational Submittals:

1. Special shipping, storage and protection, and handling instructions.

2. Manufacturer’s printed installation instructions.

3. List special tools, materials, and supplies furnished with equipment for use prior to and during startup and for future maintenance.

4. Operation and Maintenance Data.

5. Manufacturer’s Certificate of Proper Installation.

1.4 WARRANTY

A. Rotary Lobe Pumps supplied under this section shall be warranted to be free from defects in workmanship, design, and materials for a period of 2 years from shipment. If any part of the equipment should prove to be defective during the warranty period, the manufacturer at no expense to the Owner shall replace the part.

PART 2 PRODUCTS

2.1 MANUFACTURER

1. Boerger
2. Vogelsang
3. LobePro
4. Approved equal

2.2 GENERAL

A. All equipment shall be designed and built for 24-hour continuous service at any and all points within the specified range of operation, without overheating, without cavitation, and without excessive vibration or strain.

B. The pumping units required under this section shall be complete. All parts shall be so designed and proportioned as to have liberal strength, stability, and stiffness and to be especially adapted for the service to be performed. Ample room for inspection, repairs, and adjustment shall be provided.

C. All working parts of the pumps and motors, such as bearings, wearing rings, shaft, sleeves, etc., shall be standard dimensions built to limit gauges or formed to templates, such that parts will be interchangeable between like units and such that the Owner may, at any time in the future, obtain replacement and repair parts for those furnished in the original machines.

D. The nameplate ratings of the motors shall not be exceeded, nor shall the design service factor be reduced when the pump is operating at any point on its characteristic curve at maximum speed.

E. Mechanical equipment, including drives and electric motors shall be supplied and installed in accordance with applicable Occupational Safety and Health Administration (OSHA) regulations. The noise level of motors, unless otherwise noted, shall not exceed 85 A-weighted decibels (dBA) measured 3 meters from the unit under free field conditions while operating on utility power.

F. All lubrication fitting shall be brought to the outside of all equipment so that they are readily accessible from the outside without the necessity of removing covers, plates, housings, or guards.

G. The Rotary Lobe Pumps shall be designed to be abrasion resistant for applications in wastewater treatment plants. The pump shall have a minimum displacement of 47.3 gallons per 100 revolutions.

H. The ratio of the axial length of the lobe as compared to the lobe diameter (length/diameter) shall not exceed 1.0.

I. All fluid-wetted parts including the mechanical seal shall be replaceable through the quick release front cover without disassembly of coupling, drive unit or the pipe system.

J. The pumps shall be designed to temporarily run dry and to operate in either direction. Oil-quench for protection of the mechanical seal is mandatory. Seal water flush systems are not acceptable.

K. The pumps shall be constructed with an oil-filled intermediate chamber between the pump casing and the gearbox with the following functions:

1. Oil-Quench (lubrication and cooling) of the mechanical seals

2. Detection of seal failures

3. Buffer zone to the sealed timing gear

L. Oil drain of gearbox and intermediate chamber shall be easily accessible with side mounted drain screw. Oil drain under the pump is not acceptable.

M. The rotor/shaft connection shall be oil-lubricated fed by an intermediate chamber and shall not come in contact with the pumped fluid.

2.3 OPERATING CONDITIONS AND PERFORMANCE

Equipment Name	WAS pump	Thickened WAS pump
Equipment Number	PMP-430-10 PMP-430-11 PMP-430-12	PMP-710-01
Fluid Type	Wasted Activated Sludge (WAS)	Thickened Wasted Activated Sludge (TWAS)
Solids Content	< 1.5%	3% - 6%
Temperature	Ambient	Ambient
pH Value	Neutral	Neutral
Specific Gravity	1.0	1.02
Capacity, gpm	25-40 gpm	25-45 gpm
Discharge Pressure	1 psi	10
Suction Condition	Flooded	Flooded
Maximum pump speed, rpm	250	250
Minimum pump speed, rpm	120	120
Minimum motor, hp	2	5

Motor with VFD?	YES	YES

2.4 PUMP CONSTRUCTION

A. The pump casing shall be manufactured in a single block construction (Cast iron ASTM A48 grade 40, Brinell hardness 264 Brinell). Multiple Piece Design Pump Casings held together by screw connections are not acceptable.

B. The rear of the pump casing and the front cover shall be protected with replaceable wear plates with a hardness of 550 Brinell. The front cover protection plate shall be reversible. The pump casing shall be equipped with radial pump casing protection plates. Pump casings without radial liners are not acceptable.

C. The quick release cover shall be held in place by four eye nuts. The stationary threaded studs shall keep the front cover on the same level as the pump casing in the process of opening the pump for easy handling.

D. Rotors shall be tri-lobe screw design and shall consist of a non-sludge-wetted cast iron core entirely coated with abrasion-resistant Buna-N or have replaceable rotor tips that are coated with Buna-N. Stacking of lobes is not acceptable. Rotors shall be keyed to the shaft and secured with one central screw to a cylindrical thread inside the shaft. The cast iron core of the rotor shall be equipped with a female thread to enable the removal of the rotor from the shaft with ease. Rotor/shaft designs with a cover disc and/or spring washers are not acceptable.

E. The shafts shall be non-sludge-wetted. The rotor/shaft connection shall be lubricated with quench fluid of the intermediate chamber. The shafts shall be timed in their rotation by straight cut timing gears running in a separate oil chamber, which also contains the ball and roller bearings for each shaft. Sludge wetted rotor/shaft connections are not acceptable. The shafts shall be constructed from AISI 4140 carbon steel.

F. The pumps shall be fitted with maintenance free, quenched mechanical seals with duronit seal faces. The seals shall be operating in a common oil-filled intermediate chamber (Quench for lubrication and cooling). Purge systems for the seals are not acceptable. The rotating holding bush shall be locked in a fixed radial position by a keyway that also holds the rotor in place. Seal designs that open during rotor replacement are not acceptable. No sleeves shall be necessary for the mechanical seal set up. Design of the pump shall allow removal and replacement of the seal via the front cover.

G. Bearings and timing gear shall be located in a common oil-filled cast iron gearbox, fitted with a built-in sight glass to monitor oil level. The timing gear shall maintain non-contact between the rotors. Bearing life to be designed for L-10 bearing life rating of 100,000 hours at design conditions.

H. Suction and discharge connections from galvanized steel shall be American National Standards Institute (ANSI) 150-pound flanges.

I. Pump and drive fitted on common base, made from galvanized steel.

2.5 SPARE PARTS

A. One set of mechanical seals and O-rings for each pump model

B. One set of lobes and O-rings for each pump model

C. One set of axial protection plates for each pump model

D. One set of radial liners for each pump model

E. One set of special tools for each pump model

2.6 MOTORS

A. Each unit shall consist of a pump with a gear reducer and 1800 rpm electric motor.

B. The motor shall be 3-phase, 60-hertz, 460-volt with 1.15 service factor and Class F Insulation.

C. All motors shall be built in accordance with latest National Electrical Manufacturers' Association (NEMA), Institute of Electrical and Electronics Engineers (IEEE), ANSI and American Bearing Manufacturers Association (AFBMA) standards where applicable.

PART 3 EXECUTION

3.1 INSPECTION

Inspect pumps and fittings before installation to verify quality of material.

3.2 INSTALLATION

A. Install in accordance with manufacturer's printed instructions.

B. Level base by means of steel wedges (steel plates and steel shims). Wedge taper not greater than 1/4 inch per foot. Use double wedges to provide level bearing surface for pump and driver base. Accomplish wedging so there is no change of level or springing of baseplate when anchor bolts are tightened.

C. Adjust pump assemblies so driving units are properly aligned, plumb, and level with driven units and interconnecting shafts and couplings. Do not compensate for misalignment by use of flexible couplings.

D. After pump and driver have been set in position, aligned, and shimmed to proper elevation, grout space between bottom of baseplate and concrete foundation with a poured, nonshrinking grout of the proper category. Remove leveling wedges after grout is set and pack void left with grout.

E. Connect suction and discharge piping without imposing strain to pump flanges.

3.3 STARTUP AND TESTING

A. See Section 01 75 16, Start-Up Procedures for additional requirements.

B. Pre-operational Checks:

1. Check pump and motor alignment.
2. Check for proper motor rotation.
3. Check pump and drive units for proper lubrication.

C. Manufacturer’s Representative:

1. Furnish a representative of the manufacturer to perform inspection, start-up, and training services.

2. The manufacturer's representative shall be experienced in the operation and maintenance of the equipment and shall instruct the Owner’s personnel in the operation and maintenance of the equipment, including step-by-step troubleshooting with necessary test equipment.

3. Check pump and motor for high bearing temperature and excessive vibration.

4. The representative shall check the installation and supervise initial start-up of the equipment, and shall perform, at a minimum, the following tests on each pump:

   a. Measure and record actual flow, operating head and power draw at actual operating head.

   b. Measure and record operating head at two separate partially throttled flow rates.

   c. Measure and record static head.

   d. Duplicate all normal operating modes and all failure modes.

5. Manufacturer’s Written Certification:

   a. The manufacturer’s representative shall verify the complete assembly for proper alignment and connection, and quiet operation.

   b. This service shall be provided for a minimum period of one trip and 1-day.

   c. After the installation and operation of the equipment has been certified, the manufacturer's representative shall train the Owner’s personnel in the proper operation and maintenance of the equipment.

END OF SECTION

SECTION 43 25 00 – SUBMERSIBLE AXIAL FLOW PUMPS

PART 1 GENERAL

1.1 SUMMARY

A. This section includes: Variable speed, submersible, horizontal propeller pumps complete with motor, guide rail system and all appurtenances listed herein to make a complete system for pumping mixed liquor with solids concentration up to 5,000 milligrams per liter (mg/L).

1.2 SUBMITTALS

A. Shop Drawings and Product Data: Submit the following as a single complete initial submittal in accordance with Section 01 33 00:

1. Product data fully describing all items proposed for use to demonstrate that the equipment conforms to the Specifications, including drawings, specifications, installation and design details, catalogue cut-sheets. Include a list of materials of construction for all components.

2. Motor data.

3. Pump curves for each pump. For variable speed pumps, show the family of curves for every 10 Hz interval superimposed over the system curve.

4. Shop Drawings: Submit signed and sealed structural calculations and detailed drawings for the attachments and anchorage to the structure of the equipment and appurtenances in this section.

5. Submit certification from the manufacturer that the equipment is capable of resisting seismic loads.

6. System layouts and/or schematics, including connection and installation details of discharge chutes.

7. Elementary and connection wiring diagrams clearly showing external connections to other equipment.

8. Control description and control logic diagram.

B. Manuals: The Contractor shall furnish manufacturer's installation, lubrication, operation and maintenance manuals, bulletins, and spare parts lists.

C. Affidavit: The Contractor shall furnish affidavits from the manufacturer stating that the pumps have been properly installed and tested, and each is ready for full time operation.

D. Performance Testing: Certified non-witnessed factory performance tests in accordance with Hydraulics Institute Standards are required for each pump. Obtain favorable review from the Engineer prior to shipment of the pump.

1.3 QUALITY ASSURANCE

A. All equipment furnished under this Section shall: 1) be of a manufacturer who has been regularly engaged in the design and manufacture of the equipment for at least 5 years; and 2) be demonstrated to the satisfaction of the Engineer that the quality is equal to equipment made by those manufacturers specifically named herein.

1.4 WARRANTY

A. The Manufacturer of the equipment shall warrant for one- (1) year from date of startup, not to exceed 18 months from date of shipment, that all equipment provided by the Manufacturer will be free from defects in material and workmanship. In the event a component fails to perform as specified or is proven defective in service during the warranty period, the Manufacturer shall repair or replace, at his discretion, such defective part.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Wilo

B. Landia

C. Flygt

D. or approved equal.

2.2 SUBMERSIBLE PROPELLER PUMP

A. Pumps Specified herein shall operate without clogging or fouling caused by material in the pumped fluid within the range of service specified. Mixed liquor may be expected to contain gross waste solids, organic solids, animal fats, industrial solvents, emulsified oils and greases, and detergents. The pump shall be capable of operating in the range of capacity specified on a continuous basis with no detrimental effects to the pump or motor. The pump shall be designed to operate without overload at any point along the pump's entire operating curve. The design of the pump shall be such that it will not be damaged by reversed rotation caused by backflow on the pump. Pumps shall be equipped with variable frequency drives (VFDs).

B. Pump Schedule: The pump operating characteristics shall be as follows.

Equipment Name	IMLR Pump
Equipment Number	PMP-430-01 PMP-430-02
Liquid concentration	1000 - 5000 mg/L
Liquid temperature	35 – 45° F
Max. capacity at 100% speed or less	3250 gpm @ 2 ft TDH
Min. capacity at 60% speed or greater	1600 gpm @ 1.88 ft TDH
Max. propeller speed	580
Motor max. speed	1680 rpm
Adjustable speed range	30 Hz - 60 Hz
Motor max. power	13 hp
Voltage/phase	460/3
Discharge fitting size	20 in

C. Pump Construction

1. General: Submersible propeller pumps shall be axial flow propeller type, single stage, horizontal, with submersible pump and motor integrated into a single unit, semi permanently installed to a discharge pipe. The pump shall be a heavy duty, horizontally mounted axial flow tube type design. The pump, including all power train components shall be designed for variable speed operation. All components shall be capable of operating in a continuously submerged condition to a depth of 20 feet. Pump components shall have smooth surfaces devoid of irregularities or sharp transitions which could incite cavitation or trap air and debris. All mating surfaces where watertight sealing is required shall be machined and fitted with O-rings. The pump shall slide onto the seating flange coupled to the inlet end of the discharge pipe. The weight of the pump shall hold it in place without bolting. The pump shall be fitted with a lifting handle for lifting the pump out of the aeration basin with manufacturer provided davit crane. Design shall permit pump removal while the aeration basin is in operation.

2. Shroud and Seal Casing: The pump shroud and seal casing shall be cast iron (ASTM A48 Class 358 or 40) or stainless steel (ASTM A276 Type 304 or 316). Cast iron shrouds shall be provided with Type 304 stainless steel insert and protective collar. The drive unit and shroud assembly shall be equipped with a lifting handle suitable for lifting the pump off the discharge pipe.

3. Propeller and Shaft: The propeller shall be stainless steel (ASTM A276 Type 316) equipped with fixed pitch blades. Pump shafts shall be stainless steel (ASTM A276 Type 329 or 420). The rotating assembly shall be statically and dynamically balanced and shall operate at less than 80 percent of its critical speed. Shafts shall be supported by bearings with minimum L 10 life of 100,000 hours continuous operation at any condition within the range specified.

4. Mechanical seals: Pumps shall be provided with two mechanical seals running in an oil bath. Seal faces shall be silicon carbide. A moisture sensor shall be provided in the seal chamber which shall activate an alarm upon seal failure.

5. Gearbox: If needed to drive the pump, a cast iron (ASTM A48 Class 30) gear box shall be provided. The pump shaft on pumps with gear boxes shall be driven through a planetary gear reduction system, with input gear shaft mounted on needle bearings lubricated by the gear lubricant. Bearings shall be rated for a minimum L 10 life of 100,000 hours.

6. Motors: The motors shall be submersible, inverter duty rated motors conforming to the requirements of Section 26 05 84 and having an L 10 bearing life of 100,000 hours. Integral thermostats shall be provided to protect the motor from overheating. Thermostats shall be normally closed.

7. Cable: Power and control cables shall be furnished in lengths of no less than 20 feet. The cable entry design shall insure that no entry of moisture internal to the pump's motor is possible even if the power cable is severed under water. The cable entry seal design shall preclude specific torque requirements to ensure a watertight seal and shall be comprised of a cylindrical elastomer grommet having a close tolerance fit against the cable outside diameter and the entry inside diameter. The cable entry junction chamber and motor shall be separated by a stator lead sealing gland, terminal board, or epoxy barrier.

8. Pump Mounting Assembly: The pump and motor combination shall mate to a manufacturer supplied adapter piece suitable for pipe flange mounting, supported from the basin wall. Connection to the adapter piece shall be by a single downward linear motion. Design shall permit removal and installation of the pump without entry into the basin. Pump shall be guided into place by a stainless steel mast system provided with all needed supports.

D. Lifting Assembly:

1. Lifting assembly shall include a stainless steel cable connected to a short length of high tensile strength chain attached to the lifting bale of the pump. The assembly shall reach from the pump to the hand railing above. A fabricated apparatus shall be provided on the hand rail to retain the assembly above the water surface. A lifting eye shall be provided that can be attached to an external hoist. The lifting eye shall be designed to be guided down the stainless steel cable to the pump where it will engage in the pump lifting chain. The lifting system will then allow the pump to be removed from the basins in one continuous operation and without the need to reposition the lifting device on the pump lifting chain. All components shall be Type 304 stainless steel.

2.3 PORTABLE DAVIT CRANE AND BASE:

A. Portable Davit Crane and Base shall be installed and supplied by the Contractor under Specification 41 22 23.19.

2.4 SPARE PARTS

A. The following spare parts shall be provided:

1. Mechanical seal set for each pump.
2. Shaft bearing set for each pump.
3. Special tools and equipment needed for maintenance and installation.

PART 3 EXECUTION - PROVIDED BY Contractor

3.1 INSTALLATION

A. Equipment shall be installed in strict conformance with the manufacturer's installation instructions.

3.2 FIELD SERVICE

A. The manufacturer of the pump shall supply a competent field service engineer to thoroughly check and inspect the pumps after installation, place the pump in operation, participate in field startup and testing procedures, and make necessary adjustments, and instruct owner's personnel in proper operating and maintenance procedures before and after installation. A minimum of 8 hours field services shall be provided.

3.3 FIELD PAINTING

A. Pump and appurtenances shall be touched up as required and in accordance with Section 09 90 00.

3.4 FIELD TESTING

A. Each pump shall be field tested by a factory representative to verify that they are operating properly and are able to pump the design flow rate. Field testing shall be observed by the Engineer.

3.5 TRAINING

A. The manufacturer shall provide a minimum of 8 hours training to the Owner's operation staff.

END OF SECTION

SECTION 43 25 02 – SUBMERSIBLE WASTEWATER PUMPS

PART 1 GENERAL

1.1 SUMMARY

A. This Section includes furnishing, start-up, testing, and operation training for submersible sewage pumps.

B. Section includes:

1. Submersible sewage sump pumps.

C. Related Sections

1. Section 01 75 16, Start-Up Procedures
2. Section 46 05 13 General Requirements for Equipment

1.2 REFERENCE STANDARDS

A. American Society for Testing and Materials (ASTM) International:

1. ASTM A48 - Standard Specification for Gray Iron Castings
2. ASTM A276 - Standard Specification for Stainless Steel Bars and Shapes

B. National Electrical Manufacturers Association (NEMA):

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

1.3 SUBMITTALS

A. Shop Drawings and Product Data: Submit the following as a single complete initial submittal in accordance with Section 01 33 00:

1. Product data fully describing all items proposed for use to demonstrate that the equipment conforms to the Specifications, including drawings, specifications, installation and design details, catalogue cut-sheets. Include a list of materials of construction for all components.

2. Motor data.

3. Pump curves for each pump. For variable speed pumps, show the family of curves for every 10 Hz interval superimposed over the system curve.

4. Shop Drawings: Submit signed and sealed structural calculations and detailed drawings for the attachments and anchorage to the structure of the equipment and appurtenances in this section.

5. Submit certification from the manufacturer that the equipment is capable of resisting seismic loads.

6. System layouts and/or schematics, including connection and installation details of discharge chutes.

7. Elementary and connection wiring diagrams clearly showing external connections to other equipment.

8. Control description and control logic diagram.

B. Manuals: The Contractor shall furnish manufacturer's installation, lubrication, operation and maintenance manuals, bulletins, and spare parts lists.

C. Affidavit: The Contractor shall furnish affidavits from the manufacturer stating that the pumps have been properly installed and tested, and each is ready for full time operation.

1.4 CLOSEOUT SUBMITTALS

A. Project Record Documents: Record actual locations and final orientation of equipment and accessories.

B. Pump Supplier: Manufacturer’s installation and operation certificate. Statement that the equipment is suitable for the intended use.

1.5 FACTORY TESTING

A. Pump manufacturer shall provide the following factory tests in accordance with Section 43 21 00, Liquid Pumps:

1. Performance test.
2. Hydrostatic test.
3. Submersible motor integrity test.

1.6 COORDINATION

A. Like items of equipment specified herein shall be the end product of one manufacturer.

B. Electrical controls and motor design requirements are specified in this Section and Division 26, Electrical.

C. Coordinate pump requirements with the pump drive manufacturer. Contractor shall be responsible for the overall pump and drive performance.

1.7 WARRANTY

A. Submersible sewage pumps shall be warranted by the manufacturer for a minimum of 2 years from the date of installation.

PART 2 PRODUCTS

2.1 DESCRIPTION

A. Manufacturers:

1. Xylem, Flygt
2. Approved equal.

B. Identification:

Location	IPS		DPS	North RAS/WAS PS	South RAS/WAS PS
Pump Label(s)	PMP-110-01 PMP-110-02	PMP-110-03 PMP-110-04	PMP-120-01 PMP-120-02	PMP-430-03 PMP-430-04 PMP-430-08 PMP-430-09	PMP-430-05 PMP-430-06 PMP-430-07
Quantity	2	2	2	4	3

C. Power and Motor Requirements:

Voltage	460	460	460	460	460
Phase	3	3	3	3	3
Frequency	60 Hz	60 Hz	60 Hz	60 Hz	60 Hz
Motor Speed	1,770	1,185	1,755	1,800	1,765 rpm
Motor Horsepower	30	85	25	3	12

D. Performance Requirements at Full Pump Speed, One Pump Running

Location	IPS		DPS	North RAS/WAS PS	South RAS/WAS ps
Duty Point 1 Minimum Flow Capacity	6200 gpm	1200 gpm	1200 gpm	360 gpm	700 gpm
Duty Point 1 Total Dynamic Head	42 ft	60 ft	56 ft	13 ft	37.5 ft
Duty Point 1 Minimum Pump Efficiency	75%	75%	70%	50%	70%
Maximum NPSH required at Duty Point 1	28 ft	23 ft	21.5 ft	14 ft	23.5 ft

E. Operating Conditions:

Duty	Continuous	Continuous	Continuous	Continuous	Continuous
Drive	VFD	VFD	VFD	VFD	VFD
Ambient Environment	Wet Well - Corrosive	Wet Well - Corrosive	Wet Well - Corrosive	Wet Well - Corrosive	Dry Well
Ambient Temperature	33° - 104° F	33° - 104° F	33° - 104° F	33° - 104° F	33° - 104° F
Fluid Service	Municipal wastewater, raw and unscreened, containing rags, grit, fats, oil, and debris.	Municipal wastewater, raw and unscreened, containing rags, grit, fats, oil, and debris.	Municipal wastewater, Mixed Liquor, Stormwater Runoff, containing rags, grit, fats, oil, and debris.	Mixed Liquor, containing fats, oil, and debris.	Mixed Liquor, containing fats, oil, and debris.
Minimum Solids Passing Capability	3-inch	3-inch	3-inch	3-inch	3-inch
Fluid Temperature	35° - 60° F	35° - 60° F	35° - 60° F	35° - 60° F	35° - 60° F
Fluid pH	6.0 to 8.0	6.0 to 8.0	6.0 to 8.0	6.0 to 8.0	6.0 to 8.0

Fluid Specific Gravity	1.0	1.0	1.0	1.0	1.0
NPSH Available	33 ft	33.5 ft	34 ft	42 ft	39 ft

F. Pumping System Dimensions:

Location	IPS		DPS	North RAS/WAS PS	South RAS/WAS PS
Minimum Pump Discharge Size	12 in	6 in	6 in	3 in	6-inch
Base Elbow Discharge Size	12 in	6 in	6 in	4 in	6-inch
Discharge Flange Rating (ANSI)	**Class 125**	**Class 125**	**Class 125**	**Class 125**	**Class 125**
Minimum Submersible Cable Length	As Required	As Required	As Required	As Required	As Required

2.2 PUMP CONSTRUCTION

A. Pump, General:

1. Heavy-duty, vertical, submersible pump with integral drive motor, single suction, centrifugal, sewage type, suitable for a permanent-type wet well installation.

2. Major pump components shall be of gray cast iron, ASTM A48, Class 35B, with smooth surfaces devoid of blow holes or other casting irregularities.

3. All exposed nuts or bolts shall be American Iron and Steel (AISI) type 304 stainless steel.

4. All metal surfaces in contact with the pumped media, other than stainless steel, shall be protected by a factory applied spray coating of acrylic dispersion zinc phosphate primer with a polyester resin paint finish on the exterior of the pump.

B. Impeller:

1. ASTM A-532 (Alloy III A), 25 percent chrome cast iron, dynamically balanced, semi-open, multi-vane, back-swept, non-clog design.

2. Vane leading edges shall be mechanically self-cleaned upon each rotation as they pass across spiral grooves located on the volute suction, which shall keep them clear of debris, maintaining an unobstructed impeller leading edge and sustaining a high level of hydraulic efficiency.

3. Screw-shaped leading edges of the gray-iron impeller shall be hardened to Rc 45 and shall be capable of handling solids, fibrous materials, heavy sludge, and other matter normally found in raw wastewater.

4. Screw shape of the impeller inlet shall provide an inducing effect for the handling of sludge and rag-laden wastewater.

5. Impeller shall be locked to the shaft, held by an impeller bolt and treated with a corrosion inhibitor.

C. Volute:

1. Single piece gray cast iron, ASTM A-48, Class 35B, non-concentric design with smooth passages of sufficient size to pass any solids that may enter the impeller.

2. Minimum inlet and discharge size shall be as specified.

3. The volute shall have a replaceable suction cover insert ring in which are cast spiral-shaped, sharp-edged groove(s).

4. The spiral groove(s) shall provide trash release pathways and sharp edge(s) across which each impeller vane leading edge shall cross during rotation so to remain unobstructed.

5. The insert ring shall be cast of ASTM A-532 (Alloy III A), 25 percent chrome cast iron and provide effective sealing between the multi-vane semi-open impeller and the volute housing.

D. Shaft:

1. Pump and motor shaft shall be a solid continuous shaft.

2. The pump shaft shall be an extension of the motor shaft.

3. Couplings will not be acceptable.

4. The pump shaft shall be stainless steel ASTM A479 S43100-T.

5. The shaft shall be adequately designed to endure alternating bending stresses and to provide for minimum overhang to reduce shaft deflection and prolong bearing life.

E. Bearings:

1. The pump shaft shall rotate on at least three grease-lubricated bearings.

2. The upper bearing, provided for radial forces, shall be a single roller bearing.

3. The lower bearings shall consist of at least one roller bearing for radial forces and one or two angular contact ball bearings for axial thrust.

4. The minimum L10 bearing life shall be 100,000 hours at any point along the usable portion of the pump curve at maximum product speed.

5. The lower bearing housing shall include an independent thermal sensor to monitor the bearing temperature.

F. Mechanical Seal:

1. Each pump shall be provided with a tandem mechanical shaft seal system consisting of two totally independent seal assemblies.

2. The lower seal shall be independent of the impeller hub. The seals shall operate in a lubricant reservoir that hydrodynamically lubricates the lapped seal faces at a constant rate.

3. The lower, primary seal unit, located between the pump and the lubricant chamber, shall contain one stationary and one positively driven rotating corrosion resistant tungsten-carbide seal ring.

4. The upper, secondary seal unit, located between the lubricant chamber and the motor housing, shall contain one stationary and one positively driven rotating corrosion resistant tungsten-carbide seal ring. Each seal interface shall be held in contact by its own spring system.

5. The seals shall not require maintenance or adjustment and shall be capable of operating in either clockwise or counterclockwise direction of rotation without damage or loss of seal. Should both seals fail and allow fluid to enter the stator housing, a port shall be provided to direct that fluid immediately to the stator float switch to shut down the pump and activate an alarm.

6. Any intrusion of fluid shall not come into contact with the lower bearings.

7. Conventional double mechanical seals with a single or a double spring between rotating faces, or that require constant differential pressure to affect sealing and are subject to opening and penetration by pumping forces, will not be acceptable.

8. Each pump shall be provided with a lubricant chamber for the shaft sealing system. The lubricant chamber shall be designed to prevent overfilling and to provide lubricant expansion capacity. The drain and inspection plug, with positive anti-leak seal, shall be easily accessible from the outside. The seal system shall not rely upon the pumped media for lubrication.

9. The motor shall be able to operate continuously while not submerged without damage while pumping under load. Seal lubricant shall be US Food and Drug Administration (FDA) approved.

G. Cooling System:

1. Each pump/motor unit shall be provided with an integral, self-supplying cooling system. The motor water jacket shall encircle the stator housing and shall be of cast iron, ASTM A 48, Class 35B. The water jacket shall provide heat dissipation for the motor regardless of whether the motor unit is submerged in the pumped media or surrounded by air.

2. After passing through a classifying labyrinth, the impeller back vanes shall provide the necessary circulation of the cooling liquid, a portion of the filtered pump media, through the cooling system. Two cooling liquid supply pipes, one discharging low and one discharging high within the jacket, shall supply the cooling liquid to the jacket.

3. An air evacuation tube shall be provided to facilitate air removal from within the jacket. Any piping internal to the cooling system shall be shielded from the cooling media flow allowing for unobstructed circular flow within the jacket about the stator housing. Two cooling liquid return ports shall be provided.

4. The internals to the cooling system shall be non-clogging by virtue of their dimensions. Drilled and threaded provisions for external cooling and seal flushing or air relief are to be provided.

5. The cooling jacket shall be equipped with two flanged, gasketed, and bolted inspection ports of not less than 4-inch diameter located 180 degrees apart.

6. The cooling system shall provide for continuous submerged or completely non-submerged pump operation in liquid or in air having a temperature of up to 40 degrees Celsius (C) (104 degrees Fahrenheit (F)), in accordance with NEMA standards. Restrictions limiting the ambient or liquid temperatures at levels less than 40 degrees C are not acceptable.

H. Pump Discharge Elbow:

1. The pump discharge connection shall be the elbow type.

2. The discharge connection shall be bolted to the structure as recommended by the manufacturer and shall serve as a lower attachment for the guide rails, and as anchorage for the pump.

3. The anchorage system shall be designed to transmit all forces safely to the structure and may incorporate intermediate supports as required.

4. The design shall be non-sparking and shall conform to Underwriters Laboratories (UL) requirements for installation in a Class 1, Division 1, Group D hazardous location.

5. When in place, the discharge connection shall cause a watertight seal between the pump and the discharge elbow, accomplished by a machined metal to metal contact only, using simple linear downward motion of the pump with the entire weight of the pumping unit guided to and pressing tightly against the discharge connections.

6. Sealing of the discharge interface with a diaphragm, O-ring, or profile gasket shall not be acceptable. No portion of the pump shall bear directly on the floor of the wet well and no rotary motion of the pump shall be required for sealing.

I. Dual Rail Guide System

1. The pump shall be provided with a dual rail guide system to automatically and firmly connect the pump to the discharge piping when lowered into place on the discharge elbow.

2. Once the pump has been positioned on its support fitting at the discharge elbow, the guide rail system shall not be required for pump support.

3. The guide rail system shall allow easy removal of the pump without entering the wet well or disturbing the discharge piping. Single rail systems are not acceptable.

4. All components of the guide system and pump anchorage shall be of stainless steel.

J. Lifting Devices:

1. Each pump shall be provided with Type 316 stainless steel lifting chain and shackles of adequate strength to support 150 percent of the entire pump and motor assembly weight.

2. Provide Type 316 hammerlock link and U-Bolt as shown on the Drawings.

3. All lifting devices shall be rated as lifting devices and shall be provided with certification indicating they are rated for lifting device service.

4. Minimum chain size shall be 5/16-inch.

2.3 MOTORS

A. General:

1. Each pump shall be provided with a vertically mounted electric motor that conforms to the following requirements:

    a. Motors shall be designed to accept the total, unbalanced thrusts imposed by the pump.

    b. The motor and the pump shall be produced by the same manufacturer.

    c. The motor shall be capable of continuous submergence underwater without loss of watertight integrity to a depth of 65 feet or greater.

B. Motor Design:

1. The pump motor shall be a NEMA B design, induction type with a squirrel cage rotor, shell type design, housed in an air filled, watertight chamber.

2. The stator windings shall be insulated with moisture resistant Class H insulation rated for 180 degrees C (356 degrees F). The stator shall be insulated by the trickle impregnation method using Class H monomer-free polyester resin resulting in a winding fill factor of at least 95 percent.

3. The motor shall be inverter duty rated in accordance with NEMA MG1, Part 31.

4. The stator shall be heat-shrink fitted into the cast iron stator housing.

5. The use of multiple step dip- and bake-type stator insulation process is not acceptable.

6. The use of bolts, pins, or other fastening devices requiring penetration of the stator housing is not acceptable.

7. The motor shall be specifically designed for submersible pump usage and designed for continuous duty pumping media of up to 40 degrees C (104 degrees F) with an 80 degrees C temperature rise and capable of at least 15 evenly spaced starts per hour.

8. The rotor bars and short circuit rings shall be made of cast aluminum.

C. Service Factors:

1. The combined service factor (combined effect of voltage, frequency, and specific gravity) shall be a minimum of 1.15.

2. The motor shall have a voltage tolerance of plus or minus 10 percent.

3. The motor shall be designed for operation up to 40 degrees C (104 degrees F) ambient and with a temperature rise not to exceed 80 degrees C.

4. A performance chart shall be provided upon request showing curves for torque, current, power factor, input/output kilowatt (kW) and efficiency. This chart shall also include data on starting and no-load characteristics.

D. Moisture Protection:

1. A mechanical float switch (FLS) shall be mounted in the junction chamber to signal if there is water intrusion.

E. High Temperature Protection:

1. Thermal switches shall be embedded in the stator end coils to monitor the temperature of each phase winding.

2. One PT-100 type temperature sensor shall be installed in the stator winding.

3. These thermal switches shall be used in conjunction with and supplemental to external motor overload protection and shall be connected to the control panel.

4. The junction chamber shall be sealed off from the stator housing and shall contain a terminal board for connection of power and pilot sensor cables using threaded compression type terminals.

F. Power Cable:

1. The power cable shall be sized according to the National Electric Code (NEC) and Insulated Cable Engineers Association (ICEA) standards and shall be of sufficient length to reach the junction box without the need of any splices.

2. The power cable shall be of a shielded design in which an overall tinned copper shield is included, and each individual phase conductor is shielded with an aluminum coated foil wrap.

3. The outer jacket of the cable shall be oil resistant chlorinated polyethylene rubber.

4. The motor and cable shall be capable of continuous submergence underwater without loss of watertight integrity to a depth of 65 feet or greater.

G. Pilot Cable:

1. The pilot cable for connection to the pump protection sensors shall be shielded, twisted pair cable integral with the power cable.

H. Cable Entry Seal:

1. The cable entry seal design shall preclude specific torque requirements to ensure a watertight and submersible seal.

2. The cable entry shall consist of dual cylindrical elastomer grommets, flanked by washers, all having a close tolerance fit against the cable outside diameter and the cable entry inside diameter. The grommets shall be compressed by the cable entry unit, thus providing a strain relief function.

3. The assembly shall provide ease of changing the cable when necessary using the same entry seal.

4. The cable entry junction chamber and motor shall be sealed from each other, which shall isolate the stator housing from foreign material gaining access through the pump top.

5. Epoxies, silicones, or other secondary sealing systems shall not be considered acceptable.

2.4 PROTECTION

A. All stators shall incorporate three bi-metal thermal switches, one for each stator phase winding, connected in series to monitor temperature of the motor winding. Should high temperature occur, the thermal switches shall open, stop the motor, and activate an alarm.

B. A float switch shall be provided in the seal leakage chamber to detect water intrusion into the stator housing. When activated, the switch will activate an alarm but not stop the motor.

C. The thermal switches and float switch shall be connected to a Mini-CAS II unit. The Mini-CAS unit shall be designed for mounting in the control panel. Thermal switches shall be connected to the normally open over-temp contact of the Mini-CAS II unit, in accordance with the wiring diagram in the Plans.

2.5 OTHER REQUIREMENTS

A. The head-capacity curve shall exhibit a uniformly rising characteristic from free discharge to shutoff. The pump motor shall be non-overloading at a flow rate equal to 125 percent of Duty Point 2 without employing the service factor.

B. The entire pump assembly shall be UL approved as Explosion Proof for operation in a Class 1, Division 1, Group D hazardous location.

PART 3 EXECUTION

3.1 INSPECTION

Inspect pumps and fittings before installation to verify quality of material.

3.2 INSTALLATION

A. Installation:

1. Install and align pumps and fittings in accordance with the manufacturer's printed specifications and at the locations shown on the Drawings.

2. Use anchor bolts furnished or recommended by the manufacturer.

3. Place the pumps using equipment templates.

B. Anchorage:

1. Anchors for the unit shall be set in the concrete. Unit shall be mounted as instructed by the manufacturer.

2. Anchors shall be drilled and set with epoxy.

3. Provide 24 hours' notice prior to installing base elbows, to allow for anchor bolt inspection.

4. The manufacturer shall supervise installation to ensure that the unit is properly aligned and leveled; that all electrical and piping connections are properly made; and that lubricants have been provided and installed.

3.3 STARTUP AND TESTING

A. See Section 01 75 16, Testing, Training, and System Start-Up for additional requirements.

B. Pre-operational Checks:

1. Check pump and motor alignment.
2. Check for proper motor rotation.
3. Check pump and drive units for proper lubrication.

C. Manufacturer's Representative:

1. Furnish a representative of the manufacturer to perform inspection, start-up, and training services.

2. The manufacturer's representative shall be experienced in the operation and maintenance of the equipment and shall instruct the Owner’s personnel in the operation and maintenance of the equipment, including step-by-step troubleshooting with necessary test equipment.

3. Check pump and motor for high bearing temperature and excessive vibration.

4. The representative shall check the installation and supervise initial start-up of the equipment, and shall perform, at a minimum, the following tests on each pump:

    a. Measure and record shutoff head and power draw at shutoff head.

    b. Measure and record actual operating head and power draw at actual operating head.

    c. Measure and record operating head and power draw at two separate partially throttled flow rates.

    d. Measure and record static head.

    e. Duplicate all normal operating modes and all failure modes, including the removal and installation of pumps from the wet well using the guide rail system.

5. Testing shall include a comparison of measured installed flow and head, including shutoff head, with the manufacturer’s curve value. Any discrepancy shall be resolved prior to acceptance by the Owner.

6. Manufacturer’s Written Certification:

    a. The manufacturer’s representative shall verify the complete assembly for proper alignment and connection, and quiet operation.

    b. This service shall be provided for a minimum period of one trip and 1-day.

    c. After the installation and operation of the equipment has been certified, the manufacturer's representative shall train the Owner’s personnel in the proper operation and maintenance of the equipment.

D. Verify pumps are operating at the design duty condition. Remove and replace units that do not meet the design operating criteria.

E. For all pump tests, ensure that the force main is full of liquid during the testing. The Contractor shall provide the necessary water and other materials required for the testing as defined herein and recommended by the manufacturer. All testing shall use clean water as required by Section 01 75 16, Testing, Training, and System Start-Up.

F. Submersible Pump Lift Test:

1. Lift each submersible pump above the access hatch and then lower the pump back down onto the discharge elbow to demonstrate adequate clearances, smooth operation of the guide rail system, and proper re-seating of the pump on the discharge elbow.

G. A start-up report, acceptable to and approved by the Engineer, shall be completed by the manufacturer's representative before final acceptance of the pumps.

END OF SECTION

SECTION 46 05 13 – GENERAL REQUIREMENTS FOR EQUIPMENT

PART 1 GENERAL

1.1 SUMMARY

A. SCOPE: This section specifies general requirements applicable to all equipment. Ensure all equipment meets the requirements of this Section and the requirements of each individual equipment specification.

1.2 QUALITY ASSURANCE

A. REFERENCE STANDARDS:

1. This Section incorporates by reference the latest revisions of the following documents. They are part of this Section insofar as specified and modified herein. In the event of conflict between the requirements of this Section and those of the listed documents, the requirements of this Section shall prevail.

   a. ABMA Std 9 Load Ratings and Fatigue Life for Ball Bearings

   b. ABMA Std 11 Load Ratings and Fatigue Life for Roller Bearings

   c. ANSI B1.1 Unified Inch Screw Threads (UN and UNR Thread Form)

   d. ANSI B1.20.1 Pipe Threads, General Purpose (Inch)

   e. ANSI B16.1 Gray Iron Pipe Flanges and Flanged Fittings

   f. ANSI B18.2.1 Square and Hex Bolts and Screws (Inch Series)

   g. ANSI B18.2.2 Square and Hex Bolts (Inch Series)

   h. ANSI S2.19 Mechanical Vibration – Balance Quality Requirements of Rigid Rotors, Part 1

2. Unless otherwise specified, references to documents shall mean the documents in effect on the effective date of the Agreement. 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.

B. UNIT RESPONSIBILITY:

1. Where specified in the individual equipment specification, ensure equipment assemblies made up of two or more components are provided as a working unit by the unit responsibility manufacturer. The unit responsibility manufacturer shall select, design, and provide all components such that equipment specified in the individual equipment specification, and all equipment specified elsewhere but referenced in the individual equipment specification, is compatible and operates reliably to achieve the specified performance requirements. The unit responsibility manufacturer shall be the driven equipment manufacturer. Agents, representatives, or entities not a direct division of the driven equipment manufacturing corporation will not be accepted as a substitute for the driven equipment manufacturer meeting this requirement.

2. Ensure all equipment assemblies are products for which unit responsibility has been accepted by the unit responsibility manufacturer(s). Unit responsibility for related components does not require or obligate the unit responsibility manufacturer to warranty the workmanship or quality of components not manufactured by them. Where an individual equipment specification requires the Contractor to designate a unit responsibility manufacturer, the certificate shall conform to the content, form and style of Form 46 05 13-C specified in Section 01 31 30, shall be signed by an officer of the unit responsibility manufacturer's corporation, and shall be notarized. No other submittal material will be processed until a Certificate of Unit Responsibility has been received and has been found satisfactory. Failure to provide acceptable proof that the unit responsibility requirement has been satisfied will result in withholding payment approval for the subject equipment even though the equipment may have been installed in the work.

C. BALANCE:

1. For machines 1.0 HP and greater, all rotating elements in motors, pumps, blowers and centrifugal compressors shall be fully assembled, including coupling hubs, before being statically and dynamically balanced. All rotating elements shall be balanced to the following criteria:

$$U_{per} = 6.015 \frac{GW}{N}$$

Where:

Uper	=	permissible imbalance, ounce-inches, maximum
G	=	Balance quality grade, millimeters per second
W	=	Weight of the balanced assembly, pounds mass
N	=	Maximum operational speed, rpm

2. Where specified, balancing reports, demonstrating compliance with this requirement, shall be submitted as product data. Equipment balance quality grade shall be G 2.5 (G = 2.5 mm/sec) or better in accordance with ANSI S2.19.

1.3 SEISMIC AND ANCHOR BOLT REQUIREMENTS

A. Anchor and brace equipment to resist seismic loads specified in Section 40 05 93. Seismic design and engineering calculations in accordance with Section 40 05 93. Anchor bolt design and material accordance with Section 05 05 23.

PART 2 PRODUCTS

2.1 FLANGES AND PIPE THREADS

A. Flanges on equipment and appurtenances provided under this section shall conform in dimension and drilling to ANSI 816.5 Class 150, except where noted. Pipe threads shall conform in dimension and limits of size to ANSI B1 .1, coarse thread series, Class 2 fit.

B. Threaded flanges shall have a standard taper pipe thread conforming to ANSI B1 .20.1. Unless otherwise specified in the individual equipment specification, provide flat faced flanges.

C. Flange assembly bolts shall be heavy pattern, hexagonal head, carbon steel machine bolts with heavy pattern, hot pressed, hexagonal nuts conforming to ANSI 818.2.1 and 818.2.2. Threads shall be Unified Screw Threads, Standard Coarse Thread Series, Class 2A and 28, ANSI 81 .1.

2.2 BEARINGS

A. Unless otherwise specified in the individual equipment specification, equipment bearings shall be oil or grease lubricated, ball or roller type, designed to withstand the stresses of the service specified. Each bearing shall be rated in accordance with the latest revisions of ABMA Methods of Evaluating Load Ratings of Ball and Roller

Bearings. Equipment bearings shall have a minimum L-1.0 rating life of 50,000 hours. The rating life shall be determined using the maximum equipment operating speed.

B. Grease lubricated bearings, except those specified to be factory sealed and lubricated, shall be fitted with easily accessible grease supply, flush, drain and relief fittings. Extension tubes shall be used when necessary. Grease supply fittings shall be standard hydraulic alemite type.

C. Oil lubricated bearings shall be equipped with either a pressure lubricating system or a separate oil reservoir type system. Each oil lubrication system shall be of sufficient size to safely absorb the heat energy normally generated in the bearing under a maximum ambient temperature of 60 degrees Celsius and shall be equipped with a filler pipe and an external level indicator gage.

D. For bearings accessible to touch, located within 7 feet measured vertically from floor or working level, or within 15 inches measured horizontally from stairways, ramps, fixed ladders or other access structures: incorporate either bearing housings with sufficient cooling to maintain surface temperature at or below 65 degrees Celsius for continuous operation at bearing rated load and a 50 degrees Celsius ambient temperature, or provide appropriate shielding to prevent inadvertent human contact.

2.3 V-BELT ASSEMBLIES

A. Unless otherwise specified in the individual equipment specification, V-belt assemblies shall be Dodge Dyna-V belts with matching Dyna-V sheaves and Dodge Taper-lock bushings, Wood's Ultra V-belts with matching Ultra-V sheaves and Wood's Sure-Grip bushings, or Approved Equal.

B. Sheaves and bushings shall be statically balanced. Additionally, sheaves and bushings which operate at a peripheral speed of more than 5500 feet per minute shall be dynamically balanced. Mount sheaves separately on their bushings by means of three pull-up grub or cap tightening screws. Key seat bushings to the drive shaft.

C. Select belts for not less than 150 percent of rated driver horsepower. Where two sheaves sizes are specified, shall be capable of operating with either set of sheaves. Provide antistatic belts where explosion proof equipment is specified. Multiple belts shall be in matched sets.

2.4 COUPLINGS

A. Unless otherwise specified in the individual equipment specification, equipment with a driver greater than 1/2 horsepower, where the input shaft of a driven unit is directly connected to the output shaft of the driver, shall have its two shafts connected by a flexible coupling which accommodates angular misalignment, parallel misalignment and end float, and which cushions shock loads and dampens torsional vibrations. The flexible member shall consist of a tire with synthetic tension members bonded together in rubber. Attach flexible member to flanges by means of clamping rings and cap screws; the flanges shall be attached to the stub shaft by means of taper lock bushings which shall give the equivalent of a shrunk-on fit. There shall be no metal-to-metal contact between the driver and the driven unit. Each coupling shall be sized and provided as recommended by the coupling manufacturer for the specific application, considering horsepower, speed of rotation, and type of service.

B. Where torque or horsepower ratings exceed the above coupling's capacity, Falk Steel Flex, Thomas-Rex, or Approved Equal couplings are acceptable provided they are sized in accordance with the equipment manufacturer's recommendation, and sizing data are submitted; install in accordance with the coupling manufacturer's recommendation.

2.5 SHAFT CONNECTIONS

A. Prior to assembly, keys, keyways, collets, retaining bolts, couplings, and other shaft attachment assemblies used to attach impellers, fan blades, sheaves, couplings, or other rotating elements to drive shafts and driver shafts with an anti-seize compound as recommended by the equipment manufacturer.

B. Provide anti-seize or anti-galling compound with a molybdenum disulfide and graphite combination in aluminum complex base grease; conform with MIL-PRF-907E. Candidate products include Jet Lube 550 by Jet Lube, Inc., E-Z Break by LA-CO, or Approved Equal.

2.6 GUARDS

A. Exposed moving parts shall be provided with guards which meet all applicable OSHA requirements. Guards shall be fabricated of 14-gage steel, 1/2-13-15 expanded metal screen to provide visual inspection of moving parts without removal of the guard. Guards shall be galvanized after fabrication and shall be designed to be readily removable to facilitate maintenance of moving parts. Reinforced holes shall be provided. Lube fittings shall be extended through guards.

2.7 GAGE TAPS, TEST PLUGS AND GAGES

A. Provide gage taps on the suction and discharge of pumps, blowers, and compressors.

2.8 NAMEPLATES

A. Provide nameplates on each item of equipment or instrumentation for which an equipment number or instrument tag number is listed and shall contain the specified equipment name or abbreviation and equipment number. Equipment nameplates shall be engraved or stamped stainless steel and fastened to the equipment in an accessible and visible location with stainless steel screws or drive pins.

2.9 LUBRICANTS

A. For each mechanical equipment component, provide a supply of the required lubricant adequate to last through Commissioning. Lubricants shall be as recommended by the equipment manufacturer and be products of the Owner's current lubricant supplier. Consolidate various lubricants, with the equipment manufacturers' approval, into the fewest number of different types. Provide a consolidated list showing the lubricants required for each mechanical equipment component; estimated lubricant quantities needed for a full year's operation, assuming continuous operation.

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 46 21 13 – MECHANICALLY CLEANED BAR SCREENS

PART 1 GENERAL

1.1 SUMMARY

A. This section includes the furnishing of a front-cleaning, front-return link driven mechanically cleaned bar screen assembly and any auxiliary equipment or accessories to be installed in the location as indicated on the drawings and as specified herein.

B. All equipment supplied under this section shall be furnished by or through a single Screening System Supplier who shall coordinate with the Contractor, the design, fabrication, delivery, installation, and testing of the screening components. The Screening System Supplier shall have the sole responsibility for the coordination and performance of all components of the screenings system with the performance and design criteria specified herein.

C. The Contractor shall be responsible to coordinate all details of the screening equipment with other related parts of the Work, including verification that all structures, piping, wiring, and equipment components are compatible. The Contractor shall be responsible for all structural and other alterations in the Work required to accommodate the equipment differing in dimensions or other characteristics from that contemplated in the Contract Drawings or Specifications.

1.2 RELATED SECTIONS

A. The following list of related sections is provided for the convenience of the Contractor and is for reference only to support commonly referenced sections that are in-general applicable to all equipment supplied. (For complete list of sections see specification index.)

1. All sections of Division 1 including but not limited to Submittal Procedures, Shop Drawings, Product Data and Samples, Operation and Maintenance (O&M) information, Protection of Materials and Equipment, Installation, Testing, and Commissioning, Instruction of Operations and Maintenance Personnel, and Spare Parts Maintenance Manuals.
2. Section 05 05 23 Structural Metal Fasteners
3. Section 09 90 00 – Painting and Coating
4. Section 46 05 13 - General Requirements for Equipment
5. Section 26 05 84 - Electric Motors

6. Section 26 27 16 – Local Control Panels

1.3 REFERENCE STANDARDS

A. American National Standards Institute (ANSI)
B. American Society for Testing and Materials (ASTM)
C. American Welding Society (AWS)
D. American Institute of Steel Construction (AISC)
E. American Bearing Manufacturers Association (ABMA)
F. American Gear Manufacturers Association (AGMA)
G. National Electrical Manufacturers Association (NEMA)
H. Underwriters Laboratory (UL)

1.4 SUBMITTALS

A. The equipment manufacturer shall submit the following items in accordance with section 01 33 00:

1. General Arrangement drawings that illustrate the layout of the equipment, equipment weight, principal dimensions with related verifications required for installation including anchorage locations. Other related data including descriptive literature, Electrical Control Drawings, Catalog Cut Sheets for individual components and Drive Motor Data.

2. A list of recommended Spare Parts including any Special Tools required for routine maintenance of the equipment is provided in Section 2.5.

3. Manufacturer's standard Programmable Logical Controller (PLC) code used in the typical screen control panel, in electronic format, for Contractor's reference.

4. O&M Manuals including As-Built Drawings of the Mechanically Cleaned Bar Screen Arrangement, Controls and Accessories shall be provided in digital format after equipment ship for inclusion in the Close-Out Submittal process.

1.5 QUALITY ASSURANCE

A. The Mechanically Cleaned Bar Screens shall be fully assembled, and shop tested at the manufacturing facility prior to shipment. Shop testing shall include a minimum of 4 hours of run time. The contractor, the engineer, the owner or the owner's designated representative reserves the right to witness the shop test. A minimum 3-week notice shall be provided prior to the test to allow for travel coordination.

B. To assure quality and performance: All equipment furnished under this Section and related sections shall be of a single manufacturer who has been regularly engaged in the design and manufacture of the equipment and demonstrates, to the satisfaction of the Engineer, that the quality is equal to equipment made by those manufacturers specifically named herein. And the screen manufacturer shall have at least 25 installations of the specified model of mechanically cleaned bar screen equipment that has been in successful operation, at similar installations, for at least 5 years. Upon request, the manufacturer shall provide a reference of such installation sites along with the relevant contact information.

Possible consideration may be given to manufacturers with less installation experience but only upon submission and approval of dimensional and installation drawings and O&M Manuals. Additionally, a complete product development plan with dates indicating all applicable alpha and beta testing shall be provided for review and acceptance.

Approval of any manufacturer that does not meet the installation experienced defined herein shall be contingent upon submission and approval of the previously defined information. Additionally, such manufacturers shall be required to provide a performance bond issued in favor of the owner, covering the full amount of the manufacturer's offering and for the entire warranty period of the project.

C. The equipment furnished shall be fabricated, assembled, installed, and placed in proper operation condition in full conformity with approved drawings, specifications, engineering data, and/or recommendations furnished by the equipment manufacturer.

1.6 WARRANTY

A. Manufacturer shall provide a written 1-year standard warranty from the date of use of the mechanically cleaned bar screen equipment to guarantee that there shall be no defects in material or workmanship in any item supplied.

B. Manufacturer shall warrant for the period of 5 years all rotating parts of the Mechanically Cleaned Bar Screen including the gear motor, bearing, drive head, and the link system including the links, castings, pins, and retaining rings. Manufacturer warrants that these components shall be replaced if damaged or defective in the normal use of the equipment.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Screens shall be as manufactured by Duperon Corporation, 1200 Leon Scott Court, Saginaw, Michigan, TF 800.383.8479. The screens shall be the FlexRake® Model, Full Penetration Fine Screens.

B. Or pre-approved equal. Screen manufacturer seeking pre-approval must submit application a minimum of 3 weeks prior to bid day. Charges for additional engineering to alter site drawings to meet the intention of the specification shall be at the cost of the manufacturer requesting such change. The necessary submission to be considered a pre-approved equal shall include the following information:

1. Product data sheet
2. Site Specific Proposal Drawing
3. Installation drawings and instructions
4. O&M Manual
5. An employee list of in-house design engineers along with their respective locations and resumes.
6. An employee list of in-house controls engineers along with their respective locations and resumes.
7. An employee list of in-house application engineers along with their respective locations and resumes.
8. An employee list of in-house project managers along with their respective locations and resumes.
9. An employee list of in-house field service technicians along with their respective locations and resumes.

2.2 BASIS OF DESIGN

A. The mechanically cleaned bar screen shall have a head sprocket only, with no sprockets, bearings, idlers, or similar drive components under water to trap the chain. Equipment featuring reciprocating rake arms or lower bearings/sprockets/tracks below the water is not acceptable.

B. The mechanically cleaned bar screen shall meet the total screen debris removal capacity of:

Scraper Ratio below Water Level:

$$\frac{\text{Upstream Water Level (ft)}}{1.745\text{ ft}} = \text{Number of Scrapers below Water level}$$

Debris Volume per Linear Foot = 0.152 ft^3 /ft (0.046 m^3/m)

Total Screen Debris Removal Capacity on Low (ft^3/hr) =

($0.152\ ft^3/ft$) x (Screen Width) x 60 x (Number of Scrapers below Water Level)

Total Screen Debris Removal Capacity on High (ft^3/hr) =

($0.152\ ft^3/ft$) x (Screen Width) x 260 x (Number of Scrapers below Water Level)

C. The flow ability of the screen area, specifically, shall be defined as follows: A composite number representing the specific flowability of a screen area composed of the bars' Hydraulic Headloss

Coefficient Shape Factor, the bar width and the clear opening of the screen field per formula below.

$$(\text{Coefficient Shape Factor}) \times \left(\frac{\text{Bar Width}}{\text{Clear Opening}}\right) = \left(\frac{0.190}{\text{Clear Opening}}\right)$$

D. The mechanically cleaned bar screen shall be designed to run continuously (24/7), without operator.

E. The equipment shall have multiple scrapers on the bar screen at one time cleaning continuously from bottom to top, the entire width of the bar screen. The drive output shaft rotation shall be constant and in one direction in order to reduce maintenance and increase product life. Units which have single raking arms or that require cycle times shall not be allowed. Cleaning mechanisms that utilize shock absorbers, springs or other dampening or hydraulic actuations are unacceptable.

F. The link system shall have jam evasion capability by flexing around and collecting large objects such as a 2 X 4, bowling ball, grease balls, and surges of solids at peak loading times without overloading and shutting down the unit. The link system shall be such that it bends in one direction only which allows it to become its own lower sprocket and frame and shall have a 1,000-pound lifting capacity.

G. Designs employing the use of endless moving media or cables and hydraulic cylinders to remove debris from the channel and units utilizing proximity or limit switches for reverse cycles are not acceptable.

H. Equipment utilizing a greater than 1/2-horsepower motor or two or more motors to complete a screen cleaning cycle is not acceptable.

I. The design shall be such to ensure that all maintenance can be accomplished at the operating floor level or above. No part of the drive system including sprockets shall be located below the water surface at maximum design flow.

2.3 DESIGN CONDITIONS:

Number of units	*Two*
Equipment Tag Number	SCN-210-01, SCN-210-02
Channel Width:	4 ft
Channel Height:	5 ft
(upstream clearance) Channel Depth:	5 ft
Bar Opening Size:	1/4"
Angle of Installation:	20° From Vertical
Average Flow:	1.5 MGD
Average Water Level:	2 ft
Maximum Flow:	12.4 MGD
Maximum Water Level:	3.5 ft, With two screens in operation
Maximum Head Differential:	6 in
Equipment Location	Indoors (Headworks Building)
Installation Area Classification:	Class I Div 2
Collection and Conveyance	*Sluice by Duperon*
Containment Height:	*5 ft min*
Debris Bin:	*2 yd Dumpster*
Conveyor:	*N/A*
Washer/Compactor:	*Yes by Duperon*

2.4 COMPONENTS

A. **Bar screen assembly**: Bar screen assembly shall be of stainless steel and designed to withstand 1-foot head differential unless noted otherwise in Section 2.2 J Design Conditions. Unless noted otherwise materials of construction shall be 304 Stainless Steel. A stainless steel channel bottom plate shall be an integral part of the bar screen assembly to fully engage scrapers in the bar screen at the base of the unit and assure that the raking mechanism reaches the bottom of the screen to prevent debris accumulation. The Bar screen assembly shall be shipped in one piece.

1. **Screen Bars**: Bars shall be 316L stainless steel and be tear-shaped with a Hydraulic Coefficient shape factor of 0.76 and the minimum dimensions of 0.25-inch by 0.75-inch by 0.13 inch. Bars shall be individually replaceable without welding.

2. **Side Fabrication**: The screen framework shall be 304 stainless steel bent plate with minimum of 3/16-inch cross section. Horizontal members shall be of stainless steel bent plate or stainless steel pipe. Support members and frame shall adequately support the bar screen based on site specific requirements.

3. **Dead Plate:** Dead plate shall be 0.25-inch-thick 304 stainless steel. The dead plate shall be flat and true; span the entire width of the unit; and transition from bar screen to discharge point.

4. **Discharge Chute:** The discharge chute shall be 11-gauge (0.12-inch) 304 stainless steel. The discharge chute shall be bolted to the dead plate and shall be designed to allow debris to be transferred from discharge point into the debris containment.

5. **Link Slides:** Link slide assembly shall be provided per manufacturer standard design and shall be constructed of UV Stable ultra-high-molecular-weight polyethylene (UHMWPE) rollers and 304 stainless steel supports and components.

B. **Return Guide/Closeouts:** Return guide/Closeouts shall be 304 stainless steel and shall assure proper alignment of scrapers as they enter the bar screen and assure that there is no space wider than the clear opening between bars to prevent passage of larger solids than allowed through the screen.

C. **Debris Blade:** A 304 stainless steel and UV Stable UHMWPE debris blade assembly, which does not require a separate drive, shall be installed to assist in removing debris from the scraper on the mechanically cleaned bar screen unit as recommended by the manufacturer. Hydraulic, shock, or spring-controlled debris blade mechanisms are not acceptable.

D. **Screen Enclosure:** A 14-gauge #4 brushed satin finish 304 stainless steel enclosure shall be installed to cover the screen above the operating deck level. Front Enclosure shall have removable panels for access to equipment. Removable panels shall be 16-guage 304 stainless steel and shall be provided with knurled knobs for "no tool required" access. Alignment notches shall be included to support repositioning of removable panels. Rear Enclosure shall have hinged removable doors and shall be secured with a lift-slide-latch handle. Rear removable door shall include an integral viewing door that shall be secured with a lift-slide-latch handle to provide access for a quick look inside.

E. **Link System:** The link system shall be passivated stainless steel castings and have a minimum ultimate strength of 60,000 pounds with a minimum cross section of 1.5 inches and weighing a minimum of 4.5 pounds each. Parts must meet ASTM A380 specification for surface finish.

1. 304 stainless steel system includes 302 stainless steel retaining rings and 304 stainless steel pins.

F. **Scrapers:** Scrapers shall be spaced 21 inches apart. To provide long product life the scraper shall move at no greater than 28 inches per minute at standard operating speed of 1/2 revolutions per minute (rpm) allowing for approximately one debris discharge per minute. Staging Scrapers and Thru Bar Scrapers shall be a maximum ratio of 3:1 per manufacturer recommendations. At least one scraper every 84 inches shall fully penetrate the bar screen, cleaning all three sides of the bars as well as through to the cross members in openings of 0.25, 0.375 and 0.50 inches.

1. Staging Scrapers; Staging Scrapers shall be 1-inch thick by 4 inches by screen width UV Stable UHMWPE with a serrated edge.

2. Thru Bar Scrapers: Thru Bar Scrapers shall be minimum .375-inch-thick by 5 inches by screen width 304 stainless steel.

G. Drive Head: The Drive Head shall be located at the top of the mechanically cleaned bar screen.

1. Drive Unit: Each mechanically cleaned bar screen unit shall operate independently and shall have its own drive unit and driven components.

   a. Drive Sprockets shall be coated ASTM A48, CL40 cast iron with ASTM A536 80-55-06 ductile cast iron end castings.

   b. Drive Shaft shall be American Iron and Steel Institute (AISI) 1018 steel

   c. Gearbox shall be shaft-mounted, right angle type and include spiral bevel gearing. The output shaft speed shall be controlled by a vector type inverter or per rake manufacturer's recommendation. It shall have at least a 1.52 or greater service factor based on machine torque requirements. The gearbox shall not be vented to the outside atmosphere. The gearbox shall be grease filled. Oil filled gearboxes are not allowed.

   d. The motor shall be alternating current (AC) induction type, inverter duty, 3-phase 240/480-volt and mounted to the gear reducer. The motor shall be 1/2-horsepower, designed for 1800 RPMs base speed and rated for Class I, Groups C & D, Class II Groups F & G environments. The motor shall have an explosion-proof non ventilated (EPNV) enclosure, NEMA design B with a 56C frame size. Service factor shall be 1.0 or greater, Class F insulation and be optimized for insulated-gate bipolar transistor (IGBT) type inverters. The motor must be UL listed and designed for continuous operation.

   e. Motor shall have built in, normally closed, thermostat to protect from overheating that is to be field wired to corresponding terminal in control panel for redundant (ambient) overload protection.

   f. All drive head components shall be of components available in the United States.

2. Bearing: Bearing shall be greased ball bearing type, non-self-aligning, sealed and lubricated and shall have a 24/7/365 L10 life of 20 years when in compliance with stated O&M recommendations. Non-sealed bearings are not acceptable.

3. **Speed Reducer:** Speed reducer shall be a double-reduction, cycloidal style and shall comply with all applicable AGMA standards. The speed reducer shall be capable of a 4/1 speed range with variable output speeds between 0.50 to 2.2 output RPMs (in high flow conditions). The speed reducer shall produce an output torque of 11,417-inch-pound and have a gear ratio of 809:1.

H. **Standard Coating:** All non-stainless bar screen components shall be coated in strict accordance with the paint manufacturer's specification. Surface Preparation shall be done in accordance with The Society for Protective Coatings (SSPC)-SP-10 Near White. The three-part coating system shall be manufactured by Tnemec as follows: Prime Coat Series 90-97 Tneme Zinc at 2.5-3.5 mils dry-film thickness (DFT), Intermediate Coat Series 27 F.C. Typoxy at 3.0-5.0 mils DFT, and Top Coat Series 1075U Endura-Shield II at 2.0-3.0 mils DFT. Standard color is 11SF Safety Blue. Material shall meet all state and federal volatile organic compound (VOC) and other regulatory requirements.

Alternatives: Any alternate products must provide certified test reports when submitting products other than those specified herein the specification. Test reports shall indicate the test method, system, and requirements for those products being submitted, and shall meet or exceed the test criteria and performance values of the specified coatings herein.

2.5 ELECTRICAL, CONTROLS, INSTRUMENTATION

A. General:

1. Controls for each rake and associated instrument will be incorporated directly into the Plant Control System without equipment main control panel. The bar screen Manufacturer shall be responsible for providing the required sizing information of the electrical components in the Manufacturer's scope of supply. All motors shall operate at 480 VAC unless specified otherwise.

2. The equipment Manufacturer shall supply all required control components to provide for proper operation of the Bar Screen system by the Plant Control System. All control components shall be 120 VAC unless noted otherwise. This includes but is not limited to ultra-sonic level sensors, Local Control Push Button Station and similar.

A. The screen Manufacturer shall verify all overload settings in the rake controller to ensure proper overload and speed settings required for the application are properly programmed.

3. All field wiring and power cables between the bar screens and the Local Control Push Button Station, and the Plant Control System shall be provided by the Contractor under the Electrical Section.

4. All motors provided as a part of the specified equipment shall be Variable Frequency Drive (VFD) rated.

5. Wiring between the motors and the Plant Motor Control Center will utilize VFD rated cable (Belden #29502 or equal) .

B. Components:

1. Local Control Push Button Station: Each screen shall have a Local Control Push Button Station.

    a. Enclosure shall be NEMA 7/9 rated for Classified area installation. Local push button station must be local to the equipment to maintain requirements of local safety codes as determined by the Engineer.

    b. Local station shall be mounted within 10 feet or as close to the equipment as safely possible and be field wired by the electrical subcontractor.

    c. The remote pushbutton station shall include Forward, Jog Reverse and E-Stop buttons.

2. Instrumentation: Each raking assembly shall have a separate level system that shall be installed, and field wired by the electrical subcontractor per the Manufacturer's instructions.

    a. Differential Level Control: Shall be accomplished by the Plant Control Panel. That program will include differential setpoints used to automatically start/stop the rake based on the headloss across the screen. The "Rake Run Low Speed" setpoint will bring the rake to start at the low speed. The "Rake Run High Speed" setpoint will ramp the screen rake to a higher speed. The operator input "Screen Minimum Run Time" setpoint is used to help avoid intermittent starting/stopping caused by the differential level equalizing with minimal rake run time. Cycle timing logic will also be included in the program that shall function in parallel with the differential level control logic for optimal rake run time. The equipment Manufacturer shall provide input reading any other operational requirements for supplied equipment.

    b. Level sensing instrumentation shall be installed upstream and downstream from the rake and shall be:

        1) Siemens HydroRanger 200 with two Ultrasonic Level Transducers. Transducers shall be installed upstream and downstream of the rake, at least 1-foot above the highest anticipated water elevation and the beam angle shall not have obstructions between the transducer face and the water surface.

2.6 SPECIALTY TOOLS, SPARE PARTS, AND LUBRICATION

A. Manufacturer shall provide any specialty tools and recommend spare parts required for maintaining the equipment as follows:

1. Drive Clevis Pin (1)
2. Snap/Retaining Rings (10)
3. Link Clevis Pins (4)
4. Scraper Bolts (4)
5. Scraper Nuts (4)
6. Snap Ring Tool (1)
7. Never Seez, 1 oz. tube (1)

B. Manufacturer shall provide one tube of multi-purpose grease which is a 5-year supply of lubrication, required for maintaining all bar screen components.

PART 3 EXECUTION

3.1 SHIPMENT

Shipment of all equipment shall be coordinated to allow the screen shipment as one complete integrated assembly unless otherwise specified by the customer, contractor, or engineer.

3.2 INSTALLATION

A. Equipment shall be installed in strict conformance with the manufacturer's installation instructions, as submitted with Shop Drawings, Operation and Maintenance Manuals, and/or any pre-installation checklists. Installation shall utilize standard torque values and be installed secure in position and neat in appearance. Installation shall include any site preparation tasks as required by the engineer or manufacturer; such as unloading, touch-up painting, etc. and any other installation tasks and materials such as wiring, conduit, controls stands as determined by the customer and/or specified by the manufacturer.

B. Anchor Bolts: Anchor bolts and nuts shall be 316 stainless steel and furnished for each item of equipment by the Contractor.

1. Anchor bolt template drawings shall be included in the submittal to permit verification of the location structural elements, new or existing in the concrete.

2. Anchor bolt sizes, quantity, and requirements will be indicated on the submittal drawings. Quantity is site specific but typically each bar screen assembly requires eight to twelve 1/2-inch diameter by 4-1/2-inch long. embed HILTI HAS RODS w/ HIT-RE 500 V3 adhesive system anchor bolts for Mechanical Screen anchorage and

typically eight to twelve 3/8-inch diameter by 3-3/8-inch long embed HILTI HAS RODS w/ HIT-RE 500 V3 adhesive system anchor bolts for the Return Guide/Closeouts anchorage.

3.3 TESTING

A. After completion of installation, Contractor shall provide for testing and shall be performed in strict conformance with the Manufacturer's start up instructions. Testing of the bar screen shall demonstrate that the equipment is fully operational by picking up and depositing materials into specified containment.

B. Field certification shall include inspection of the following:

1. Verify equipment is properly aligned and anchored per the installation instruction and drawings. Assure the bar screen unit is square, flat and unobstructed with required clearances maintained.

2. Assure controls and instrumentation work in all modes.

3. Check equipment for proper operation of debris blade, scrapers, etc. as well as completion of the Start-Up requirements in the installation guide.

3.4 MANUFACTURER'S SERVICES

A. Manufacturer shall provide services to include Installation Certification and shall include 1 day for Start-Up and 1 day for Training.

END OF SECTION

SECTION 46 21 73 – SCREENINGS WASHING AND COMPACTING EQUIPMENT

PART 1 GENERAL

1.1 SUMMARY

A. SCOPE OF WORK This section includes the furnishing, installation and testing of an interleaving, dual auger washer compactor assembly as shown on the drawings and as specified herein. A single unit shall provide washing and compacting action on wastewater screenings.

B. All equipment supplied under this section shall be furnished by or through a single System Supplier who shall coordinate with the Contractor, the design, fabrication, delivery, installation, and testing of the screening washing and compacting components. The screening washer and compactor System Supplier shall have the sole responsibility for the coordination and performance of all components of the system with the performance and design criteria specified herein.

C. The Contractor shall be responsible to coordinate all details of the screening equipment with other related parts of the Work, including verification that all structures, piping, wiring, and equipment components are compatible. The Contractor shall be responsible for all structural and other alterations in the Work required to accommodate the equipment differing in dimensions or other characteristics from that contemplated in the Contract Drawings or Specifications.

1.2 RELATED SECTIONS

A. The following list of related sections is provided for the convenience of the Contractor and is for reference only to support commonly referenced sections that are in-general applicable to all equipment supplied. (For complete list of sections see specification index.)

1. All sections of Division 1 including but not limited to Submittal Procedures, Shop Drawings, Product Data and Samples, Operation and Maintenance (O&M) information, Protection of Materials and Equipment, Installation, Testing, and Commissioning, Instruction of Operations and Maintenance Personnel, and Spare Parts Maintenance Manuals.

2. Section 05 05 23 Structural Metal Fasteners

3. Section 09 90 00 – Painting and Coating

4. Section 26 05 84 - Electric Motors

5. Section 46 05 13 - General Requirements for Equipment

6. Section 46 21 13 – Mechanically Cleaned Bar Screens

1.3 REFERENCE STANDARDS

A. American National Standards Institute (ANSI)
B. American Society for Testing and Materials (ASTM)
C. American Welding Society (AWS)
D. American Institute of Steel Construction (AISC)
E. American Bearing Manufacturers Association (ABMA)
F. American Gear Manufacturers Association (AGMA)
G. National Electrical Manufacturers Association (NEMA)
H. Underwriters Laboratory (UL)

1.4 SUBMITTALS

A. The equipment manufacturer shall submit the following items in accordance with section 01 33 00:

1. Four sets of shop drawings, including: Main Layout Drawings, List of Equipment Specifications, and recommendations furnished by the Equipment Manufacturer.

2. Four sets of as-built drawings of washer compactor structure, controls, and accessories (as applicable).

    1. Manufacturer's standard Programmable Logical Controller (PLC) code for the complete screening's washer compactor's operation, in electronic format, for Contractor's reference.

2. List of Spare Parts and Special Tools (as applicable).

3. Four sets of Operation and Maintenance (O&M) Manuals (including as-built drawings) to be provided after equipment ships for inclusion in the close-out Submittal process.

1.5 QUALITY ASSURANCE

A. The washer compactor shall be fully assembled, and shop tested at the manufacturing facility prior to shipment. Shop testing shall include a minimum of 4 hours of run time.

B. To assure quality and performance: All equipment furnished under this Section and related sections shall be of a single manufacturer who has been regularly engaged in the design and manufacture of the equipment and demonstrates, to the satisfaction of the Engineer, that the quality is equal to equipment made by those manufacturers specifically named herein. And the washer compactor manufacturer shall have at least 25 installations of the specified model of Washer Compactor equipment that has been in successful operation, at similar installations, for at least 5 years. Upon request, the manufacturer shall provide a reference of such installation sites along with the relevant contact information.

Possible consideration may be given to manufacturers with less installation experience but only upon submission and approval of dimensional and installation drawings and O&M Manuals. Additionally, a complete product development plan with dates indicating all applicable alpha and beta testing shall be provided for review and acceptance.

Approval of any manufacturer that does not meet the installation experienced defined herein shall be contingent upon submission and approval of the previously defined information. Additionally, such manufacturers shall be required to provide a performance bond issued in favor of the owner, covering the full amount of the manufacturer's offering and for the entire warranty period of the project.

C. The equipment furnished shall be fabricated, assembled, installed, and placed in proper operation condition in full conformity with approved drawings, specifications, engineering data, and/or recommendations furnished by the equipment manufacturer.

1.6 WARRANTY

A. Manufacturer shall provide a written 1-year standard warranty from the date of use of the Washer Compactor equipment to guarantee that there shall be no defects in material or workmanship in any item supplied.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Washer Compactor shall be as manufactured by Duperon Corporation.

B. Or pre-approved equal. Washer Compactor manufacturer seeking pre-approval must submit application a minimum of 3 weeks prior to bid day. Charges for additional engineering to alter site drawings to meet the intention of the specification shall be at the cost of the manufacturer requesting such change. The necessary submission to be considered a pre-approved equal shall include the following information:

1. Product data sheet
2. Site Specific Proposal Drawing
3. Installation drawings and instructions
4. O&M Manual

5. An employee list of in-house design engineers along with their respective locations and resumes.

6. An employee list of in-house controls engineers along with their respective locations and resumes.

7. An employee list of in-house application engineers along with their respective locations and resumes.

8. An employee list of in-house project managers along with their respective locations and resumes.

9. An employee list of in-house field service technicians along with their respective locations and resumes.

2.2 BASIS OF DESIGN

A. **Compacting Action:** The Washer Compactor shall have dual augers to provide positive displacement action. Augers shall be oriented on top of each other and rotate in opposing directions. Augers shall be intermeshed, with one left-hand and one right-hand lead. Augers shall be designed with a limited float on top of a strainer to allow for the accommodation of irregular debris.

B. **Washing Action:** The Washer Compactor shall have a wash water manifold integrated into the main housing. Two ports inside the unit shall emit a medium pressure stream. Wash water shall run continuously when the Washer Compactor is in motion. Continuous operation (non-batching) equipment is required; filling- and batching-type equipment shall not be accepted.

C. **Operation:** The Washer Compactor shall be continuous run, not requiring an operator. The Washer Compactor shall be equipped with a self-regulating, active pressure zone designed to accept non-standard wastewater debris in its original form, including but not limited to: rocks; broken concrete; and metal (such as bolts or short pipe) up to 4 inches long. The Washer Compactor shall have the ability to process multiple pieces of clothing, variable volumes of debris, and unprocessed septage or grease. The Washer Compactor shall move at a normal operating speed of 2.4 to 9.8 revolutions per minute (RPM) and shall have the ability to run intermittently to sync with upstream equipment.

D. **Materials:**

1. **Fabrications:** All welded fabrications shall be made from stainless steel. All welded connections and welding procedures shall comply with AWS "Structural Welding Code – Sheet Steel" D1.3/D1.6.

2. **Select Parts:** Select power transmission parts to be made from cast iron; however, shall conform to standard coating as follows.

3. **Standard Coating:**

   a. Motor gearbox shall be coated in strict accordance with the paint manufacturer's specification. Surface preparation shall be done in accordance with SSPC-SP-10 near White. The three-part coating system shall be manufactured by Tnemec as follows: Prime Coat Series 90-97 Tnemec Zinc at 2.5-3.5 mils DFT; Intermediate Coat Series Typoxy at 3.0-5.0 mils DFT; and Top Coat Series 1075U Endura-Shield II at 2.0-3.0 mils DFT. Standard color is 11SF Safety Blue. Material shall meet all State and Federal VOC and other regulatory requirements.

   b. Alternatives: Any alternate product must provide certified test reports when submitting products other than those specified herein. Test reports shall indicate the test method, system, and requirements for those products being submitted and shall meet or exceed the test criteria and performance values of the coatings specified herein.

4. **Non-Metal:** Parts not covered in the specifications above shall be manufactured from ultra-high-molecular-weight (UHMW) polyethylene.

E. Design Conditions:

Equipment Name	Screenings Washer/Compactor
Equipment Number	PRS-210-01
Peak Capacity:	90 cu.ft./hr (5 minutes)
Average Capacity (Continuous):	25 cu.ft./hr
Water: Typical	▪ Utilizes filtered effluent or municipal water ▪ Consumes 3-10 GPM ▪ Requires 40-60 PSI ▪ 1/2-inch NPT supply (female threads) ▪ 3-inch NPT drain (male threads)
Materials of Construction:	▪ 304 SSTL ▪ 17-4 Spur Gears

	▪ Delrin (or equivalent) thrust and plane bearings ▪ UHMW Auger Supports
Strainer:	Perforated Screen
Hopper Height (Deck to Hopper):	38”
Hopper Length (WC3.B2.X Unit):	43”
Performance Data (Typical Wastewater Debris)	
Dry Solids:	30%-60%
Mass/Weight Reduction:	60%-70%
Volume Reduction:	70%-80%
Odor/Fecal:	Significantly decreases odor/fecal
Motor/Drive	
Motor Size:	3 HP
Motor Paint:	Standard Tnemec Coating
Motor Service Factor (Minimum):	1.0
Output Speed:	9.8 RPM
Speed Reducer Ratio/Output:	179:1
Speed Reducer Paint:	Standard Tnemec Coating
Site Power	
Phase/Voltage:	240/480 volt
Controls:	by Contractor

2.3 COMPONENTS

A. **Main Housing:** The main housing of the Washer Compactor shall be constructed of stainless steel (material options contained in table) with a minimum thickness of 11 gauge. Support and flange connections shall be 3/8-inch.

B. **Hopper:** The hopper of the Washer Compactor shall be constructed of stainless steel (material options contained in table) with a minimum thickness of 11-gauge.

C. **Augers:** The augers shall be of stainless steel (material options contained in table) with 8-inch diameter flights, 3/8-inch-thick, with 4-inch flight pitch. The augers shall be coupled to a transmission at the drive end and be supported at the compaction end with UHMW plane bearings. This arrangement shall allow for the accommodation of irregular debris. The auger shaft shall be 2-inch stainless steel schedule 40 pipe with 2-inch solid stainless steel stub shaft.

D. **Compaction Housing:** The compaction housing of the Washer Compactor shall be 1/4-inch stainless steel (material options contained in table) and shall house a spring and gate assembly to provide the resistance for compaction. The compaction housing shall contain the auger supports.

E. **Discharge Chute:** The discharge chute of the Washer Compactor shall be constructed of stainless steel (material options contained in table) with a minimum thickness of 14-gauge. Support and flange connections shall be 1/4-inch. The discharge chute shall be tapered outward toward the discharge end.

F. **Water Supply:** The water supply shall connect at a single point with a 1/2-inch NPT female connector. A NEMA 7/9 Explosion proof solenoid valve is provided to limit the wash water flow to only when the washer compactor is running. Ball valves shall be provided to distribute flow to the washing and trough sprayer connections.

G. **Strainer:** A strainer shall be located beneath the lower auger to filter the washed solids. The strainer shall be removable via drain trough and pressed against the lower auger with spring pressure. The strainer shall be self-cleaning through continuous, even contact with the lower auger. Strainers requiring auger-mounted brushes will not be accepted.

H. **Drain Trough:** A removable pan shall be provided beneath the main housing to collect wash water. Wash water shall be drained through a 3-inch national pipe thread (NPT) male drain port. The pan shall be a minimum of 11-gauge stainless steel (material options contained in table).

I. **Drive Assembly:**

1. Each Washer Compactor unit shall operate independently, with its own drive unit and driven components. The gearbox shall not be vented to the outside atmosphere.

2. The gearbox shall be grease lubricated and designed for 5 years (or 20,000 hours of operation) between recommended clean and re-grease services. The gearbox shall be right angle type, and shall incorporate cycloidal and spiral bevel gearing with a total ratio of 179:1. The gear reducer output shaft speed shall be 2.4 RPM minimum to 9.8 RPM maximum and controlled by an AC Tech, vector-type inverter (or greater service factor) based on unit torque requirements. It shall be shaft-mounted utilizing the keyless Taper-Grip® bushing.

3. The motor shall be mounted to the gear reducer by utilizing a quill, C-Face mounting style. The motor shall be AC induction type, 3-horsepower, 3/60/230/460-volt, explosion-proof, inverter-duty model.

4. The drive assembly shall incorporate the Manufacturer's standard coating system.

J. Auger Transmission:

1. The Drive Assembly shall be coupled to a dual gear transmission, which drives the augers in a counter-rotation.

2. The spur gears are contained in a stainless steel housing and supported by Delrin (or equivalent) plane bearing.

3. Grease fittings shall be located outside of the transmission housing to provide lubrication to the gears.

K. Speed Reducer: The Speed Reducer shall have a maximum output of 9.8 RPM, 179:1 reduction ratio with 18,900-inch-pound of output torque.

L. Thrust Bearings: Thrust Bearings shall be Delrin (or equivalent), self-lubricating, and be capable of withstanding a minimum of 2,000 pounds of thrust load (each auger) at 9.8 RPM for life of machine.

M. Screw Supports: Screw supports shall be UHWM plane type, self-lubricating, and fastened into place using stainless steel fasteners.

2.4 ELECTRICAL, CONTROLS, INSTRUMENTATION

A. Control Panel: No control panel shall be provided by the screening's washer compactor Manufacturer. Contractor will provide wiring and control at the plant SCADA level.

B. Wash water valve wiring: the wash water solenoid valve will be provided by the Manufacture and will be installed and field wired by Contractor.

1. Local Control Push Button Station

a. Enclosure shall be NEMA 4/7/9 rated for Classified area installation. Local push button station must be local to the equipment to maintain requirements of local safety codes as determined by the Engineer.

b. Local station shall be mounted within 10 feet or as close to the equipment as safely possible and be field wired by the electrical subcontractor.

c. The remote pushbutton station shall include Forward, Jog Reverse, and E-Stop buttons.

2.5 SPECIALTY TOOLS, SPARE PARTS, AND LUBRICATION

A. Plane Bearing Kit includes:

1. Side Screw Supports (2)
2. Upper Screw Supports (2)
3. Lower Screw Supports (2)
4. FHSCS: 1/4-20 x 1.00 LG (24)
5. Washer: 1/4 Flat SAE (24)
6. Nut: 1/4-20 Nylock (24)

7. Grease Tube (14oz.) (1)
8. Never-Seez (1oz.) (1)

PART 3 EXECUTION

3.1 SHIPMENT

Shipment of all equipment shall be coordinated to allow the Washer Compactor shipment as one complete integrated assembly unless otherwise specified by the Owner, Contractor, or Engineer.

3.2 INSTALLATION

A. Equipment shall be installed in strict conformance with the Manufacturer's installation instructions, as submitted with Shop Drawings, Operation and Maintenance Manuals and/or any pre-installation checklists. Installation shall utilize standard torque values and be installed secure in position and neat in appearance. Installation shall include any site preparation tasks as required by the engineer or manufacturer; such as unloading, touch-up painting, etc. and any other installation tasks and materials such as wiring, conduit, controls stands as determined by the customer and/or specified by the manufacturer. All plumbing shall be completed on site by a qualified individual in accordance with all local and national plumbing regulations.

B. Anchor Bolts: Anchor bolts and nuts shall be 304 stainless steel and furnished for each item of equipment by the Contractor.

1. Anchor bolt template drawings shall be included in the submittal to permit verification of the location structural elements, new or existing in the concrete.

2. Anchor bolt sizes, quantity and requirements will be indicated on the submittal drawings. Quantity is site specific but typically each Washer Compactor assembly requires four 1/2-inch diameter by four 1/2-inch Lg. embed HILTI HAS RODS w/ RE-500v3 Adhesive system anchor bolts.

3.3 TESTING

A. After completion of installation, Contractor shall provide for testing and shall be performed in strict conformance with the Manufacturer's start up instructions. Testing of the Washer Compactor shall demonstrate that the equipment is fully operational, and that the equipment will wash, compact, and deposit materials not to exceed 4 inches.

B. Field certification shall include inspection of the following:

1. Verify washer compactor is properly leveled and anchored per the installation instructions and site drawings.

2. Assure controls and instrumentation work in all modes.

3. Assure proper auger rotation.

4. Check to assure all Start-Up requirements are completed per the Installation Guide.

3.4 MANUFACTURER'S SERVICES

A. Manufacturer shall provide services to include Installation Certification and shall include one day for Start-Up and one day for Training.

END OF SECTION

SECTION 46 23 23 – VORTEX GRIT REMOVAL EQUIPMENT

PART 1 GENERAL

1.1 SUMMARY

This section covers the work necessary to furnish and install, complete all necessary equipment and appurtenances for the new grit chamber equipment, including paddle apparatus, drive, fluidizer vanes, grit well cover plate, flow control baffles, grit pump, grit concentrator, and screw classifier.

1.2 RELATED SECTIONS

A. Section 03 30 00 - Cast-In-Place Concrete.
B. Section 09 90 00 - Painting and Coating.
C. Division 26, Electrical, unless specified in this Section.
D. Section 46 05 13 - General Requirements for Equipment.

1.3 REFERENCES

A. Reference Standards: Comply as a minimum with applicable provisions and recommendations of the following:

1. NEC, National Electric Code.
2. NEMA, Standards of National Electrical Manufacturers Association.
3. IEEE, Institute of Electrical and Electronic Engineers.
4. AFBMA, Anti-Friction Bearing Manufacturers Association.
5. ANSI, American National Standards Institute.
6. SSPC, Steel Structures Painting Council.
7. ASTM, American Society for Testing and Materials.

1.4 SUBMITTALS

A. Submit shop drawings and product data in accordance with Section 01 33 00.

B. Manufacturer's standard Programmable Logical Controller (PLC) code for the complete grit removal system operation, in electronic format.

C. Submit a list of not less than five installations where equipment of the type and approximate size specified herein has been in successful operation for at least 5 years.

D. Two grit removal efficiency tests shall be provided from an installation where similar equipment by the Manufacturer is currently in similar service. Each grit removal efficiency test shall meet the removal efficiency in 2.3C. To ensure compatibility and complete system integration, all pieces of equipment for the grit removal system (e.g.

grit chamber, grit pump, grit classifier,) shall be manufactured by the same company. Components from multiple manufacturers will not be acceptable.

E. Submit locations of the nearest permanent service headquarters.

F. Submit descriptive literature, including a cross-sectional view of each chamber, which indicates materials of construction, weights, principal dimensions and other important details.

G. Submit operation and maintenance data under provisions of Section 01 78 23.

H. Record Drawings: Submit record drawing under provisions of Section 01 33 00.

I. Grit system manufacturer shall provide Computation Fluid Dynamics (CFD) modeling to verify the grit chamber removal characteristics and flow regime. Data on the CFD through generic simulation results of the specified chamber diameter shall be provided with the submittal and prior to approval.

J. Grit system manufacturer shall provide calculations and supporting information to demonstrate sizing of the grit chamber based on particle size, peak flow, and chamber diameter. Units sized on Surface Overflow Rate (SOR) shall not be allowed. Details to be provided with submittal and prior to approval.

1.5 QUALITY ASSURANCE

A. All materials used shall be new, of high grade and of properties best suited to the Work required.

B. Manufacturer's Qualifications:

1. Grit chamber equipment provided under this Section shall submit a list of not less than five installations where equipment of the same removal efficiencies as specified herein has been in successful operation for at least 5 years.

2. Two grit removal efficiency tests shall be provided from an installation where similar equipment by the Manufacturer is currently in similar service. Each grit removal efficiency test shall meet the removal efficiency in 2.3.C. A Manufacturer that does not have test data that is acceptable to the Engineer shall not be considered as an approved equal. A Manufacturer that does not have test data that is acceptable to the Engineer shall not be considered as an approved equal or be required to provide grit testing of equipment.

3. Manufacturer shall satisfy the engineer that they are capable of the following:

a. Providing local factory trained personnel to service the unit and allied equipment when needed within 72-hour period.

b. Providing needed spare parts within 48-hour period.

C. Coordination Responsibility:

1. In order to ensure equipment compatibility one manufacturer shall be responsible for providing all grit removal equipment, including pump, classifier, and controls.

2. Contractor shall retain overall responsibility for equipment coordination, installation, testing, and operation.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver equipment to site under provisions of Section 46 05 13.
B. Store and protect equipment under provisions of Section 46 05 13.
C. Store all equipment off the ground in enclosed shelter.

1.7 WARRANTY

A. Manufacturer shall furnish to the owner a written warranty against workmanship and material for 1-year under normal use and service. Warranty shall be in printed form and previously published as the manufacturers' Standard Warranty for similar units.

PART 2 PRODUCTS

2.1 GENERAL

A. Furnish and install the vortex grit removal equipment and appurtenances in accordance with these specifications and as shown on the Drawings.

2.2 MANUFACTURER

A. Smith & Loveless, Inc.
B. WesTech
C. Or pre-approved equal

2.3 OPERATIONAL CHARACTERISTICS

A. Design the grit chamber for following conditions.

Equipment Name	Grit Removal System
Equipment Number	GRT-220-01 (Grit chamber paddle drive) PMP-220-01 (Grit pump) CLS-220-01 (Grit washer)
Liquid	Screened raw wastewater

Peak hour flow	12.4 MGD
Average daily flow	1.85 MGD
Min. hour flow	0.8 MGD
Motor max. power	10 hp
Voltage/phase	460/3

B. Construct suitable for extremely humid installation and splash resistant.

C. Limit head loss through grit chamber to 8.1-inch or less at 12.0 MGD.

D. Grit removal from screened raw wastewater.

% Removed	
Grit Size	(by Weight)
Down to 140-mesh particle size	95

E. Wearing parts readily accessible for inspection, repairs, and replacement.

F. Replacement parts easily duplicated and attainable.

G. No moving parts subject to wear or stoppage below water surface.

H. No bends or elbows on underwater or inaccessible grit piping.

I. Provide drives, lubrication, and support equipment bearings accessible from operating floor level.

J. No loss of grit removal efficiency for flows with inlet velocity less than 3.5 feet per second.

K. Provide inlet ramp to enhance coanda effect and direct grit downward to separation chamber.

L. Grit removal system to fit in grit tank shown on Drawings.

1. Inlet and outlet to be separated by flow control baffle and chamber travel path to be 450 degrees.
2. Storage hopper to have 60 degrees sloped bottom with a maximum diameter of 3-foot, 0-inch and a minimum depth of 5-foot, 6-inch.

2.4 GRIT CHAMBER EQUIPMENT

A. Paddles

1. Adjustable grit scouring intensity.
2. Four blades.
3. Material: 316 stainless steel.

B. Propeller Drive Tube:

1. Driven by large, totally enclosed spur gear and turntable bearing.
2. Dia: 10-3/4-inch minimum.
3. Material: 316 stainless steel.

C. Grit Fluidizer

1. Bolted to propeller drive tube.
2. Within 6 inches of pump suction inlet.
3. Helical configuration.

D. Propeller Drive Unit (Gear Motor and Gear Head):

1. Motor:
   a. Helical gear type.
   b. 230/460 volts, 3-phase, 60 hertz. Totally enclosed, fan-cooled (TEFC)
   c. Steel housing and frame.
   d. Service Factor: 2.0 or greater on reducer, 1.15 on motor.
   e. Conform to requirements of Section 26 05 84.
2. Gears:
   a. Alloy steel, heat treated, and hardened.
   b. Teeth: Hobbed and flame hardened.
   c. Helical Gears: Oil lubricated.

d. Spur Tooth Bull Gear: Large, driven by pinion mounted on output shaft of helical gear motor, enclosed in heavy cast iron case.

e. Spur Gear Pinion: Cut from heat-treated steel.

f. Bull Gear: Rotate with minimum 21-inch diameter turntable bearing.

g. Service Factor for Pinion and Bull Gear: 5 or greater at standard operating speeds.

3. Bull Gear Box:

a. Specifically designed for this service.
b. Provide opening for propeller drive table.
c. Seal with air bell at bottom opening around drive tube.
d. Provide bolted flanged connection at top for grit pump suction.

4. General Requirements:

a. Maximum Drive Output Speed: 21 revolutions per minute (rpm).

b. Suitable for continuous (24 hours per day year-round) service.

c. Bearings shall have minimum B-10 bearing life of 50,000 hours., except 21-inch diameter turntable bearing which shall have minimum B-10 life of 20 years.

E. Grit well cover plates

1. Maximum 3-inch opening between cover plate and propeller drive tube.

2. Two-piece with lifting loops.

3. Stationary, not part of rotating assembly.

4. Material: 316 stainless steel.

F. Flow Control Baffle:

1. Integral flow control baffle for both the inlet and outlet of the main chamber.

2. Material: 316 stainless steel.

3. Fabricate to dimensions as shown on Drawings.

4. No additional downstream flow control device shall be required to keep inlet channel velocity between 3.5 feet per second and 1.6 feet per second.

5. It shall be designed to direct the inlet flow into the chamber in a manner ensuring the proper vortex flow and to prevent short-circuiting.

6. It shall direct the flow out of the unit, and to act as a "slice weir" to control the water level in the main chamber and in the inlet channel.

2.5 GRIT PUMP

A. Pump:

1. Pump is mounted on top of the grit chamber as shown in the drawings.

2. Centrifugal, vertical configuration.

3. Close-coupled.

4. Recessed Ni-Hard impeller.

5. Construction: Ni-hard especially designed for use of mechanical seals and vacuum priming.

6. Size: 4-inch suction, 4-inch discharge.

7. Capable of passing 4-inch sphere.

8. Capacity: 250 GPM at 8.5 feet total dynamic head (TDH).

9. One-piece motor adapter/back head.

B. Motor:

1. 10-horsepower,1760 RPM, 230/460-Volt, 3-phase, 60-hertz (TEFC).

2. Minimum 1-7/8-inch shaft diameter.

3. Solid stainless steel shaft through mechanical seal.

4. Six-inch maximum lower bearing to impeller distance.

5. Class F insulation, Class B temperature rise, 1.15, unless explosion-proof or variable frequency drive (VFD) duty then 1.0 service factor.

6. Conform to requirements of Section 26 05 84.

C. Lifting Stanchion

1. A stanchion with lifting arm shall be provided to lift the Grit Pump for disassembly.

2. The lifting arm shall have a hook over the center of the motor to support a hoist provided by the Owner. Installation shall be as detailed in the contract drawings.

3. The lifter shall be designed for a 1,000-pound(454-kilogram) lifting load.

2.6 CENTRIFUGAL GRIT CONCENTRATOR

A. Mount grit concentrator on grit dewatering screw as recommended by manufacturer.

B. Size, capacity, and range of operation shall be compatible with total grit removal system as described herein.

C. Operates on the constant rate vortex principle.

D. Purpose: Remove water and organics from mixture of grit, water, and organics (pumped by grit pump) prior to grit dewatering screw, thereby minimizing hydraulic load.

E. Flow Pattern:

1. Pumped flow enters tangentially through side.

2. Grit and small volume of water exit out bottom into hopper of dewatering screw.

3. Organic material and rest of water exit out top to drain.

4. Minimum 93 percent removal of influent water and 95 percent removal influent organics.

5. Less than 5 percent putrescible material in recovered grit from underflow.

F. Material: Minimum 1/2-inch Ni-Hard, high nickel iron coated with minimum 6-mil dry film thickness epoxy resin.

G. No moving parts; operates totally on hydraulic principles.

2.7 GRIT WASHER

General:

- Provide inlet hopper to receive mixture of grit and water, sufficiently large to allow grit to settle out of water.
- Provide 4-inch overflow in inlet hopper.
- Provide unit as freestanding with support legs to hold conveyor at approximately 22-degree angle from horizontal.

- Drive screw conveyor with gear motor mounted on discharge end.
- The programmable logic controller (PLC) control logic will operate the grit washer through its various cycles, including air infusion, grit wash water, spray water, organic drain solenoid valves, and ejection cycle, in proper sequence.

A. Construction:

1. Screw:

   a. Diameter: 9-inch
   b. Length: 15-foot
   c. Material: (304 stainless) (316 stainless) steel.
   d. Shaftless screws not allowed due to wear or loss of grit.

2. Screw Bearings:

   a. Outlet End: Anti-friction type.
   b. Inlet End: Greaseable bronze bushing.

3. Screw Trough:

   a. Material: (304 stainless) (316 stainless) steel

   b. Open 3/16-inch steel formed, U-shaped.

   c. Provide 2-inch diameter drain at inlet end.

   d. Provide 8-inch outlet.

   e. Provide 5-foot, 1/4-inch of clearance between centerline of support legs and centerline of discharge.

4. Inlet Hopper:

   a. Material: 304 stainless steel.
   b. Overflow: Full-length, double-sided outlet weir trough with 4-inch flange.
   c. Slope three sides of hopper at least 50 degrees to horizontal.
   d. Projected Surface Area: 17.0 square feet.
   e. Parallel plates to improve retention of fine grit.

5. Drive:

   a. Provide belt driven shaft mounted helical gear reducer.
   b. Mount on plate bolted to flanges of screw trough at discharge end.

6. Motor:

a. 3-horsepower, 230/460-volt, 3-phase, 60-hertz. (TEFC).
b. Provide in accordance with Section 26 05 84.

7. Cover:

a. Material: 304 stainless steel
b. Expanded steel flattened mesh cover over hopper and trough openings.
c. Style designation: No. 13-15.
d. Opening under concentrator not covered to allow incoming flow to enter unit.

8. Wash Water Requirements:

a. 20 GPM at 60 pounds per square inch gauge of plant effluent.
b. Intermittent.
c. Water supply may be non-potable, however not wastewater.
d. If a potable supply is used, a backflow preventer should be provided.

9. Flowmeter:

a. Wash water shall be controlled by a manual valve and measured by a flowmeter.

b. Constructed with a tough machined acrylic meter body, highly polished to a clear finish with a direct reading permanent scale.

c. Float and guide rod shall be constructed of 316 stainless steel.

d. The flowmeter shall be capable of usage in direct sunlight.

10. Rotometer:

a. Scouring air shall be by a manual valve and measured by a rotometer.

b. Constructed of one piece welded 316 stainless steel with a clear, polycarbonate plastic tube shield, and Borosilicate glass tube.

c. Float shall be constructed of 316 stainless steel

d. The rotometer shall be capable of usage in direct sunlight.

11. Automatic Spring-Loaded Lubricator:

a. Unit relies on the movement of the bushing to pull grease from the refillable reservoir to the bushing surface.

b. The reservoir and base shall be constructed of clear polycarbonate, which allows for visual inspection.

c. The thread size is 1/8-inch NPT.

d. Capacity: 6-ounce (178-cubic centimeter).

e. Size: 3-inch (75-millimeter) diameter x 6-inch (150-millimeter) tall.

f. Operating Temperature Range: -10 degrees Fahrenheit (F) (-23 degrees Celsius (C)) to 250 degrees F (121 degrees C).

2.8 SHOP PAINTING

A. Surface Preparation

1. All structural steel surfaces shot blasted with steel grit.
2. Weld splatter and surface roughness removed by grinding.
3. Comply with SSPC-SP6 specifications.

B. Coating - Grit Mechanism

1. Single, 3-mil dry film thickness (DFT) primer - shop applied.

C. Coating - Concentrator and Conveyor

1. Single, 6-mil DFT epoxy resin.

2.9 ELECTRICAL AND CONTROL

A. Circuit Breakers

1. Thermal magnetic air circuit breakers shall be provided for branch disconnect service and short-circuit protection of all auxiliary circuits

2. Thermal magnetic circuit breakers with lockout capability shall be provided for each drive and pump motor, matched to the motor inrush current.

B. Starters

1. Magnetic across-the-line starters with 24-volt coils and solid-state overload protection for each phase shall be provided for each motor to give positive protection against phase unbalance, thermal overload, phase loss, and ground fault.

2. To provide the fastest trip speed and for ground fault protection, only solid-state overload protection will be used, and motor starters using heater coils will not be acceptable.

3. Each single-phase auxiliary motor shall be equipped with an over-current protection device in addition to the branch circuit breaker or shall be impedance protected.

4. Include for following motors:

   a. Paddle drive.
   b. Grit pump.
   c. Screw conveyor.

C. Control Panel

1. No control panel shall be provided by the grit system manufacturer. Contractor will provide wiring, control at the plant SCADA level.

PART 3 EXECUTION

3.1 INSTALLATION

A. Installation of the grit equipment shall be in complete accordance with the manufacturer's instructions and recommendations, and the reviewed shop drawings.

B. Prior to start up, file a certificate of proper installation.

C. Anchor Bolts: Anchor bolts and nuts shall be 304 stainless steel and furnished for each item of equipment by the Contractor.

3.2 TESTING

A. After completion of installation, Contractor shall perform testing in strict conformance with the Manufacturer's start up instructions. Testing shall demonstrate that the equipment is fully operational continuously for 3 hours.

3.3 ONSITE TECHNICAL ASSISTANCE

A. Manufacturer shall provide services to include Installation Certification and shall include 1 day for Start-Up and 1 day for Training.

END OF SECTION

SECTION 46 41 40 – SUBMERSIBLE MIXERS

PART 1 GENERAL

1.1 SUMMARY

A. This section includes: Submersible, horizontal propeller type mixers complete with motor, guide rail system, and all appurtenances to make a complete system for mixing of municipal wastewater.

1.2 SUBMITTALS

A. Shop Drawings and Product Data: Equipment supplier shall submit the following as a single complete initial submittal in accordance with Section 01 33 00:

1. Product data fully describing all items proposed for use to demonstrate that the equipment conforms to the specifications.

2. Motor data.

3. Mixer layouts and dimensions.

4. Mixer placement and orientation recommendations.

5. Materials of construction.

6. Shop Drawings: Submit signed and sealed structural calculations and detailed drawings for the attachments and anchorage to the structure of the equipment and appurtenances in this section.

7. Submit certification from the manufacturer that the equipment is capable of resisting seismic loads.

B. Manuals: Furnish manufacturer's installation, lubrication, operation and maintenance manuals, bulletins, parts lists, and spare parts lists.

C. Affidavits: Furnish affidavits from the manufacturer stating that the equipment has been properly installed and tested and each is ready for continuous operation.

D. Factory Testing: Certified non-witnessed factory tests shall be done to ensure proper operation of the mixers. Tests shall include operation in submerged conditions to verify current draw, staring capability, mechanical and electrical integrity.

E. Field Testing: Submit lab results from mixed liquor sampling for review by Owner or Engineer. Lab results shall be accompanied by a drawing indicating the location and depth of each sample.

1.3 QUALITY ASSURANCE

A. All equipment furnished under this Section shall: 1) be of a manufacturer who has been regularly engaged in the design and manufacture of the equipment for at least 5 years; and 2) be demonstrated to the satisfaction of the Engineer that the quality is equal to equipment made by those manufacturers specifically named herein.

1.4 WARRANTY

A. The Manufacturer of the equipment shall warrant for one (1) year from date of startup, not to exceed 18 months from date of shipment, that all equipment provided by the Manufacturer will be free from defects in material and workmanship. In the event a component fails to perform as specified or is proven defective in service during the warranty period, the Manufacturer shall repair or replace, at his discretion, such defective part.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Wilo

B. Landia

C. or approved equal

2.2 EQUIPMENT

A. The mixer specified herein shall be suitable for continuous mixing of mixed liquor within the anoxic process basins of a municipal wastewater plant. Mixed liquor may be expected to contain gross waste solids, organic solids, animal fats, industrial solvents, emulsified oils and greases, and detergents. Mixers shall be designed to completely mix the contents of the zones into which they are placed such that the maximum variation in concentration between samples taken from any location within the zone shall be no more than 10 percent. Mixers shall be specifically designed for continuous operation in the fluid specified without vortexing, clogging and/or buildup of debris. Each mixer located in the anoxic or swing zones will be operated under anoxic conditions at all times and will require continuous operation of the associated mixer.

B. Mixer Schedule: The mixer operating characteristics shall be as follows.

Equipment Name	Anoxic Zone Mixers	Swing Zone Mixers
Equipment Number	MIX-420-01 MIX-420-02 MIX-420-05 MIX-420-06	MIX-420-03 MIX-420-04 MIX-420-07 MIX-420-08
Basin Dimensions	18 ft x 26 ft x 13 ft to 14 ft SWD	9.5 ft x 31.5 ft x 11 ft to 12 ft SWD
Mixed Liquor concentration	1000-5000 mg/l	1000-5000 mg/l
Liquid temperature	35° F - 60°F	35° F - 60°F
Max. propeller speed	200	200
Motor max. speed	1080	1080
Motor max. power	4 hp	4 hp
Voltage/phase	460/3	460/3

C. Mixer Construction

1. General: Submersible mixers shall be horizontal, propeller type, with mixer and motor integrated into a single unit, semi permanently installed to a mounting mast. The submersible mixers shall be non-clogging, with backward curved propeller blades of a cross section, which reduces drag while eliminating fibrous build up. All components shall be capable of operating in a continuously submerged condition to a depth of 20 feet. Mixer components shall have smooth surfaces devoid of irregularities or sharp transitions which could incite cavitation or trap debris. All mating surfaces where watertight sealing is required shall be machined and fitted with O-rings. The mixer shall slide into position with assistance of a portable davit crane. The weight of the mixer shall hold it in place without bolting. The mounting assembly shall be designed to allow for horizontal rotation of the mixer to allow adjustment of the mixing angle. Mixer elevation and angle shall be set as recommended by manufacturer for optimum mixing. The mast assembly shall be designed to support the weight of the mixer and all forces associated with operation of the mixer. The mixer shall be fitted with a lifting cable system to allow lifting the mixer in one continuous operation while the aeration basin is in operation.

2. Motor Housing and Seal Casing: Motor housing and seal casing shall be cast iron (ASTM A48 Class 358 or 40) or stainless steel (ASTM A276 Type 304 or 316). The

housing assembly shall be equipped with a lifting handle suitable for lifting and removing the mixer while the mixed zone remains in operation.

3. Propeller and Shaft: The propeller shall be closed cell polyurethane equipped with fixed pitch blades. No welded steel or stainless steel propeller shall be accepted. Mixer shafts shall be Series 421 stainless steel (ASTM A276 Type 421). Propellers shall be slip fit and securely held to the shaft by a stainless steel washer and bolt assembly that is enclosed in a separate hub chamber. The hub chamber is fitted with an O-Ringed cap that seals the entrance of the propeller hub chamber device. The output shaft shall be splined to mate with the matching spline insert of stainless steel that forms the hub of the propeller. The arrangement shall be such that the propeller cannot unscrew or be loosened by torque from either forward or reverse rotation. Designs based on threaded connection between mixer shaft and impeller will not be considered. The rotating assembly shall be statically and dynamically balanced and shall operate at less than 80 percent of its critical speed. Shafts shall be supported by bearings with minimum L 10 life of 100,000 hours continuous operation at any condition within the range specified.

4. Mechanical seals: Mixer shall be provided with two mechanical seals running in an oil bath or a 4-stage labyrinth sealing system. Seal faces shall be silicon carbide. The 4-stage labyrinth sealing system shall consist of an outer seal in the propeller hub with a stainless steel spring, two inner seals on the propeller shaft with a stainless steel spring running in a grease reservoir, and a silicon carbide mechanical seal running in oil for cooling and lubrication. Two moisture sensors shall be provided in both of the seal oil chambers which shall activate an alarm upon seal failure.

5. Gearbox: If needed to drive the mixer, a cast iron (ASTM A48 Class 30) gear box shall be provided. The shaft on mixers with gear boxes shall be driven through a planetary gear reduction system, with input gear shaft mounted on needle bearings lubricated by the gear lubricant. Bearings shall be rated for a minimum L 10 life of 100,000 hours.

6. Motors: Submersible, 480 Volt, 3 phase, 60 Hertz. See Section 26 05 84 for detailed motor specifications and having an L 10 bearing life of 100,000 hours. Integral thermostats shall be provided to protect the motor from overheating. Thermostats shall be normally closed.

7. Cables: Power and control cables shall be furnished in lengths of no less than 20 feet. The cable entry design shall insure that no entry of moisture internal to the mixer's motor is possible even if the power cable is severed under water. The cable entry seal design shall preclude specific torque requirements to ensure a watertight seal and shall be comprised of a cylindrical elastomer grommet having a close tolerance fit against the cable outside diameter and the entry inside diameter. The cable entry junction chamber and motor shall be separated by a stator lead sealing

gland, terminal board or epoxy barrier. Provide relays compatible with mixer moisture and temperature sensors.

8. Mounting Assembly: A guide rail system shall be provided with all needed supports to mount the mixer and guide the mixer during installation and/or retrieval. Guide rail and mounting assembly components shall be constructed of Type 304 stainless steel. Mounting assembly shall allow for adjustment in mixer depth and angle of the mixer. Design shall permit removal and installation of the mixer without entry into the basins.

D. Lifting Assembly:

1. Lifting assembly shall include a stainless steel cable connected to a short length of high tensile strength chain attached to the lifting bale of the mixer. The assembly shall reach from the mixer to the hand railing above. A fabricated apparatus shall be provided on the hand rail to retain the assembly above the water surface. A lifting eye shall be provided that can be attached to an external hoist. The lifting eye shall be designed to be guided down the stainless steel cable to the mixer where it will engage in the mixer lifting chain. The lifting system will then allow the mixer to be removed from the basins in one continuous operation and without the need to reposition the lifting device on the pump lifting chain. All components shall be Type 304 stainless steel.

E. Portable Davit Crane and Base:

1. Portable Davit Crane and Base shall be installed and supplied by the Contractor under Specification 41 22 13.19.

2.3 SPARE PARTS

A. The following spare parts shall be provided:

1. Mechanical seal set for each mixer.
2. Shaf bearing set for each mixer.
3. Special tools and equipment needed for maintenance and installation.

PART 3 EXECUTION

3.1 INSTALLATION

A. Equipment shall be installed in strict conformance with manufacturer's installation instructions.

B. Mixer location and angle shall be set per manufacture's recommendation to assure complete mixing of the zone in which the mixer has been installed.

3.2 FIELD SERVICE

A. Provide the services of a competent manufacturer's field service engineer to thoroughly check and inspect the mixers after installation, place the mixers in operation and make necessary adjustments, and instruct plant personnel in proper operating and maintenance procedures. A minimum of 8 hours of onsite training shall be provided.

3.3 FIELD TOUCH-UP PAINTING

A. Mixer and appurtenances shall be touched up as required and in accordance with Section 09 90 00.

3.4 FIELD TESTING

A. After installation, all mixers shall be operated and tested by the Contractor. Mixers shall demonstrate compliance with the Specifications and shall operate to the satisfaction of the Engineer under actual operating conditions.

3.5 TRAINING

A. The manufacturer shall provide a minimum of 8 hours training to the Owner's operation staff.

END OF SECTION

SECTION 46 43 21 – CIRCULAR PRIMARY CLARIFIER EQUIPMENT

PART 1 GENERAL

1.1 SUMMARY

A. There shall be furnished one primary clarifier mechanism suitable for installation in the concrete basins as shown on the contract drawings.

B. Each mechanism shall be a center column supported, center feed unit with peripheral effluent collection. A center drive mechanism shall be provided for rotation of the rake arms and scum skimming mechanism.

C. The equipment shall be designed to effectively settle suspended solids and scrape the settled solids from the basin floor to the sludge withdrawal sump as shown on the drawings. The clarified effluent shall be collected uniformly by the peripheral launder. Surface scum shall be collected by the scum skimming equipment and discharged through the scum withdrawal pipe.

D. The equipment furnished for each clarifier mechanism shall include but not be limited to: walkway with handrails, center drive assembly, center drive platform, center support column with inlet openings, feedwell, center cage, sludge collection arms with rake blades, full radius surface scum skimming equipment, effluent weir plates and scum baffle, anchor bolts, and assembly fasteners.

E. Except where specifically indicated otherwise, all plates and structural members designated for submerged service shall have a minimum thickness of 1/4-inch. All structural steel will conform to American Society for Testing and Materials International (ASTM) A-36 requirements and steel plate will conform to ASTM A283C requirements. All anchor bolts and assembly fasteners shall be hot dip galvanized high strength steel. Handrail, skimmer, and rake blade squeegee fasteners shall be 304 stainless steel.

1.2 RELATED SECTIONS

A. Section 05 50 00, Metal Fabrications
B. Section 06 80 00 Glass-Fiber-Reinforced Plastic
C. Section 09 90 00, Painting and Coating

1.3 REFERENCE STANDARDS

A. ASTM:

1. A36 Structural Steel Specifications
2. A992 Structural Steel Specifications

3. 304 Bolt Specifications
4. A123 Hot-Dip Galvanized Coatings
5. A153 Hot-Dip Galvanized Bolts
6. A48 Cast Iron Specifications
7. A536 Ductile Iron Specifications
8. A283C Steel Plate Specifications

B. American Iron and Steel Institute (AISI), Heat Treated Steel Specifications

C. American Gear Manufacturers' Association (AGMA), Gear Ratings

D. American Welding Society (AWS), Current Standards

E. Anti-friction Bearing Manufacturers' Association (AFBMA), Bearing Life Specifications

F. National Electrical Manufacturer's Association (NEMA), Motor Design Standards and Standards for Control Enclosures

1.4 QUALITY ASSURANCE

A. The clarifier equipment manufacturer shall modify the standard equipment to meet the minimum values specified for dimensions, design, and the intent of this specification.

B. Manufacturers regularly engaged in the manufacture of the clarifier equipment as specified herein and who can demonstrate equipment of this specified design, in actual service for a period of not less than 10 years will be considered as acceptable manufacturers.

C. Manufacturers shall show evidence of quality assurance in manufacturing and supplying equipment essential in details to the equipment herein specified. This assurance will be met by certification to the quality system requirement of International Organization for Standardization (ISO) 9001 or equivalent standard as accepted by the engineer.

D. The clarifier will have a flat, low profile FRP cover for odor control purpose. Contractor shall coordinate with clarifier manufacturer and the FPR cover manufacturer to avoid any conflict during the installation.

1.5 SUBMITTALS

A. Provide submittal information in accordance with Section 01 33 00 – Submittal Procedures.

B. The contractor shall submit complete shop drawings of all equipment furnished for this project as covered by these specifications. The contractor's submittal must include a certification that the submitted material describes exactly the equipment to be provided. Substitutions of equipment subsequent to submittal approval will not be accepted.

C. The contractor shall submit a copy of the equipment specification section with all addenda and all referenced specification sections. Each paragraph shall be check-marked to indicate specification compliance or marked to indicate deviations from the specification requirements. Check marks shall indicate complete compliance with the paragraph requirements. Deviations from the specification shall be indicated by underlining the deviation and marking the paragraph or line with a number or letter. The remainder of the paragraph not marked as a deviation shall indicate compliance with the requirements of the paragraph. The manufacturer shall prepare a detailed justification for each deviation. Failure to include the required specification sections and the justification for deviations will indicate non-compliance and shall be rejected without further consideration.

D. The clarifier equipment manufacturer shall furnish as a minimum the following design and description information to establish compliance with these specifications:

1. Certified general arrangement and tank dimensional drawings.
2. Certificate of design stamped by a Registered Professional Engineer stating that the equipment to be provided for this project meets or exceeds all design requirements of these specifications. The certificate shall state the respective loads and design criteria.
3. Drive mechanism rating calculations, stamped by a Registered Professional Engineer, verifying the compliance of the drive gears and bearings with the specified continuous torque rating and bearing life rating.
4. Motor data and catalog information. Electrical drawings as applicable to the supply of the clarifier equipment manufacturer.
5. Catalog cut sheets for purchased sub-components.

1.6 OPERATION AND MAINTENANCE MANUALS

A. Per Section 01 78 23 – Operation and Maintenance Data

B. Operation and maintenance manuals will be provided by the clarifier manufacturer at least 2 weeks prior to shipment of all major equipment components. Each manual shall be a bound, indexed binder with drawings and parts lists prepared specifically for this project rather than general instructions that are not designed for this project.

C. As a minimum the manual shall contain:

1. Certified as-built drawings (general arrangement and general arrangement details).

2. Erection drawings.

3. A complete bill of materials for the equipment including the weights of all structural steel components.

4. Installation and maintenance instructions for the specific equipment including the erection sequence, maintenance and trouble-shooting check points, and complete lubrication procedures with recommended grades of lubricants.

5. Cut sheets for all equipment items purchased from sub-vendors.

6. A list of the clarifier manufacturer's recommended spare parts specifically denoting wear items, long delivery items, and all items convenient for stocking as optional replacement items.

1.7 WARRANTEE

A. The mechanism shall be warranted for 2 years from the time the mechanism is put into service. The drive main bearing shall be warranted for 10 years.

1.8 DELIVERY

A. Fabricated assemblies shall be shipped in the largest sections permitted by carrier regulations, properly match-marked for ease of field erection.

B. All components shall be erected immediately upon receipt from the clarifier manufacturer or stored in strict conformance with storage recommendations provided by the clarifier manufacturer in the operations and maintenance manual.

C. The mechanism shall be lubricated in strict accordance with the instructions of the clarifier manufacturer's field service representative. The required lubricants shall be provided by the contractor.

PART 2 PRODUCTS

2.1 MANUFACTURERS:

A. WesTech
B. Clearstream
C. Ovivo, USA of Salt Lake City, Utah
D. Evoqua Water Technologies in Waukesha, WI

2.2 GENERAL REQUIREMETNS

A. Each clarifier mechanism shall be of the center-drive type, supported on a stationary influent column, with the flow entering at the bottom of the influent column and flowing upward to the inlet openings located at liquid level. The clarifier shall be designed to remove sludge uniformly from the bottom of the tank.

Equipment Name	Primary clarifier
Equipment Number	CLA-310-01

2.3 PROCESS REQUIREMENTS

Design average flow	1.85 million gallons per day (MGD)
Design Peak Day flow	10.4 MGD
Drive continuous torque	15,000 foot-pound at 0.06 revolutions per minute (rpm)
Mechanism rotation	Counterclockwise (CCW)
Rake arm tip speed, constant	8 – 12 feet per minute

2.4 DESIGN REQUIREMENTS

Basin diameter	60-feet
Side water depth	10-feet
Floor slope	1:12
Center column diameter	18-inch
Feedwell diameter	12-feet
Feedwell depth	6-feet
Feedwell scum ports	four
Scum box width	4-feet

2.5 CENTER DRIVE ASSEMBLY

A. The center drive assembly shall consist of an integral motor and primary speed reducer coupled through roller chain and sprockets to a secondary worm gear reducer driving the main gear through a pinion and shall have an integral overload protection system.

B. All gears and bearings shall be oil bath lubricated with the main bearing totally submerged in oil and the teeth of the main spur gear submerged at least 85 percent in the oil bath. Oil pumps for lubrication or grease lubricated bearings are not considered appropriate for this application and will not be allowed. The oil reservoir for the main bearing and gear shall have a section of minimum depth 5 inches below the main bearing to positively prevent contamination of the main bearing and gears with condensate or other contaminants. Gear and bearing housings must also be fitted with oil level sight glasses and condensate drains. Condensate must be allowed to drain from a low point of the housing. Condensate and contaminants will not be allowed to drain through the lower pinion bearing. In lieu of the oil reservoir depth requirement a continuous oil conditioner unit installed at each drive assembly and as specified herein will be considered equal. The conditioner shall consist of an electrical continuous pre-pump filter and 150-micron stainless steel oil filter. All conditioner mounting hardware, electrical wiring and controls, and necessary piping shall be provided by the clarifier manufacturer.

C. Drive components will be located via a machined, registered fit to preserve the alignment of key drive components under all load conditions. Inspection of the completed drive unit shall be accomplished at the clarifier manufacturer's shop, with reports of all tests and certifications of material hardness being made available for review at the Engineer's request prior to shipment to the job site.

D. Major drive components, main gears, and bearings must be designed to allow for separate and individual replacement by plant personnel to facilitate quick and economical repairs.

E. The complete center drive assembly, including the overload protection device, shall be a regularly manufactured in-house product of the clarifier manufacturer. Drive assemblies purchased from third party vendors will not be accepted.

F. The motor shall be minimum 3/4-horsepower and shall be totally enclosed, fan cooled, with a 1.15 service factor, and have bearings with a minimum B10 rating of 50,000 hours. Operating electric current will be 230/460-volt, 3-phase, and 60-hertz. Each motor will be NEMA Design B employing Class F insulation designed for an ambient temperature of 40 degrees Celsius (C).

G. The primary speed reducer shall be a gearmotor reducer. The motor and primary speed reducer shall drive a secondary worm gear reducer through a #60 roller chain and steel sprockets enclosed in a galvanized 22-gauge steel guard. Sprockets and chain shall be designed for the connected horsepower of the drive with a minimum service factor of 4.0. Provision shall be made for adjustment of chain tension. Cycloidal reducers are not considered as equal and are not acceptable.

H. The main drive unit shall consist of a worm gear secondary reduction unit, pinion and main spur gear assembly. The secondary reducer shall be a worm gear reducer specifically designed for this application. The worm gear shall be centrifugally cast high strength manganese bronze. The worm shall be hardened alloy steel. A single piece pinion and shaft shall be keyed to the worm gear to transmit power from the worm gear to the spur gear. In order to maintain proper alignment between the pinion and the spur gear, the pinion will be supported by bearings both above and below the spur gear. The bearings shall be fitted into precision machined bearing pilots to positively insure bearing and gear alignment.

I. The main spur gear material shall be high strength ductile iron per ASTM A536 grade 100-70-03 or equal. The gear shall have a minimum pitch diameter of 30 inches with a 4.75-inch face height or the equivalent spur gear surface area of 447 square inches. Spur gear surface area is defined as the spur gear pitch diameter multiplied by the spur gear face height multiplied by 3.14.

J. The main gear shall rotate and be supported on a ball bearing assembly provided with four replaceable liner strips fitted into the main gear and turntable base. Liner strips shall be special vacuum degassed, carbon corrected, alloy steel hardened to a Rockwell hardness of at least 43 to 46 Rc. The turntable base shall be a minimum 1-inch thick to insure adequate structural rigidity to properly support the drive bearing and gear.

K. The main gear and bearing shall be completely enclosed in an ASTM A-48 Class 40A cast iron housing provided with neoprene dust seals. In order to ensure the maximum possible base rigidity and vibration dampening the gear housing shall be of full sidewall construction, integral with the base. If requested, shop inspection reports shall be made available for review.

L. The drive unit shall be equipped with an electro-mechanical overload control device actuated by thrust from the worm shaft. The pointer shall provide a visual reading of the relative main gear output torque on a 0 to 100 percent graduated scale. The 100 percent reading shall equal the 100 percent drive rating as specified in section 2.2. The control device shall also activate an alarm switch for warning of impending overload, a motor cutout switch for overload protection, and a back-up safety motor cutout switch for back up overload protection. In lieu of a back-up safety motor cutout switch a slip clutch assembly will be acceptable upon review by the Engineer. The respective switches in the overload control device shall be factory calibrated and set to the following settings:

1. Alarm - 40 percent of scale.
2. Motor cutout – 85 percent of scale.
3. Back-up motor cutout or slip clutch – 100 percent of scale.

All drive control components shall be mounted in a waterproof enclosure of either epoxy coated aluminum or stainless steel with a gasket sealed, removable cover. The pointer shall be covered with a clear plastic enclosure and shall be above the platform surface for visibility from the platform. Amperage sensing devices, devices with exposed linkage connections, or devices which react to rotational movement an intermediate reduction unit are not acceptable.

M. The center drive unit shall be designed for the continuous torque rating as specified in section 2.2. The continuous torque shall be defined as the minimum torque at which the drive mechanism may operate continuously 24 hours per day, 365 days per year, for 20 years, at the specified sludge collector arm speed. Main gear and pinion calculations shall be based upon American National Standards Institute (ANSI)/American Gear Manufacturers Association (AGMA) 2001 C-95 (1995) standard for rating the pitting resistance and bending strength of involute spur and helical gear teeth. Calculations shall clearly present the values used for the design parameters. Specifically, the load distribution factor shall be determined by the empirical method. For parameters which are material dependent, such as allowable contact stress, the calculations shall include a complete description of material and heat treatment used.

Worm gearing shall be designed and rated to equal or exceed the specified continuous torque and life. The basis for rating shall be ANSI/AGMA 6034-B92 standards for durability rating and design of worm gear reducers.

The continuous torque rating for the drive unit shall be the lowest value determined for the gearing.

2.6 WALKWAY ACCESS BRIDGE

A. The clarifier shall be provided with a 36-inch clear, open width walkway extending from the tank wall to the center drive platform. The walkway shall be supported at the center by the drive unit and supported on the opposite end by the tank wall. As a minimum the walkway shall be designed to safely withstand all dead loads plus a live load of 50 pounds per square foot with a maximum deflection of 1/360 of the entire span. The walkway shall consist of two beams, sufficiently braced to resist the specified design loads. The contractor shall block out or otherwise modify the tank wall to accommodate the walkway as shown on the clarifier manufacturer's shop drawings. The walkway decking shall be 1-1/4-inch aluminum I-Bar grating.

B. A center drive operations platform shall be provided. It shall be a minimum of 8 feet square to provide clearance around the center assembly and drive control for maintenance and service. The drive platform shall be decked with 3/8-inch aluminum checkered floor plate and have sufficient structural steel supports to meet the specified design load conditions.

C. Provide handrails with toe plate along both sides of the walkway and around the center drive platform. The handrails shall be aluminum per specification 05520 – Handrails. Rails are to be shipped to the job site in stock lengths for cutting and fitting. The toe plate shall be a 4-inch by 1/4-inch plate or a 4-inch-tall aluminum extruded channel.

2.7 CENTER CAGE AND RAKE ARMS

A. The center cage shall be of steel truss construction and shall be provided with connections for the two sludge removal arms and feedwell supports. The top of the cage shall be bolted to the main gear which shall rotate the cage with the attached arms and feedwell. The minimum angle size used for construction of the cage and rake arms shall be 2-inch by 2-inch by 1/4-inch members.

B. The clarifier mechanism shall include two sludge removal arms of steel truss construction with steel raking blades and adjustable 20-gauge, 304 stainless steel squeegees. The rake blades shall be properly spaced to insure complete raking of the basin floor twice per revolution.

C. The cage and rake arms shall be designed such that calculated stresses do not exceed the American Institute of Steel Construction (AISC) allowable stress at twice the drive 100 percent rating.

2.8 CENTER COLUMN

A. A 1/4-inch wall thickness, stationary center column shall be provided which shall serve as the influent pipe. One end shall have a 1-1/4-inch support flange for bolting to the foundation with a minimum of eight 1-1/4-inch diameter anchor bolts as shown on the plans. A similar flange shall be provided at the top of the column for supporting and securing the center drive assembly.

B. Influent openings shall be provided in the upper portion of the column to allow unrestricted passage of the flow into the feedwell. Influent velocity shall be reduced by providing a total inlet port area a minimum of 135 percent of the center column cross sectional area.

2.9 FEEDWELL

A. The feedwell shall be supported by structural members attached to the center rotating cage. The feedwell shall be fabricated from 3/16-inch steel plate with upper and lower reinforcing rim angles as required and stiffeners as required. A minimum of two scum ports, 4 inches high by 16 inches long, shall be provided equally spaced around the feedwell periphery to allow scum to exit from the feedwell at water level. Scum ports shall be free to allow scum to escape with an adjustable, angled baffle plate to impart a tangential direction of the flow exiting the scum port. As an alternate to scum ports and baffle plates, the feedwell rim may be submerged slightly below average liquid level to allow floating material to exit the feedwell area.

2.10 SURFACE SCUM SKIMMING EQUIPMENT

A. Surface scum skimming equipment shall be furnished with the clarifier mechanism. It shall be arranged to have the surface scum swept along an angled skimmer blade to the skimmer assembly, attached at the end of the blade, for discharge to the scum box as shown on the plans. The surface of the clarifier shall be swept once per revolution.

B. The skimmer blade shall be tangential to the rotating feedwell and be supported by vertical supports from the rake arm. The skimmer assembly shall be a pivoting aluminum skimmer device equipped with manual out-of-service lock out. The skimmer shall have replaceable neoprene rubber wipers on all three sides to form a pocket to trap the scum and discharge the scum into the scum box.

C. The scum box shall be supported from the tank wall and connected to a 6-inch scum line, as shown on the contract drawings.

D. The clarifier equipment manufacturer shall furnish a flush valve assembly for automatic flushing of the scum box and scum pipe. The flush valve assembly shall allow approximately 2 to 5 gallons of clarified effluent to enter the box as the skimmer assembly passes over the scum box. It shall consist of an actuator bar and a pivoting assembly that will open a valve. A counterweight shall close the valve after the flush cycle ends.

2.11 EFFLUENT WEIR AND SCUM BAFFLE

A. Effluent weir plates shall be per specification section 06 80 00 Glass-Fiber-Reinforced Plastic. The weir sections shall be fastened to the tank wall using 304 stainless steel cinch anchor bolts hex nuts and 5-inch diameter FRP washers, allowing for vertical adjustment. To prevent leakage all surfaces between the launder walls and weir plates shall be given a seal coat of suitable mastic by the erection contractor.

B. The scum baffle plates shall be per specification section 06 80 00 Glass-Fiber-Reinforced Plastic. Sections supported from the tank wall by FRP angle brackets secured with 304 stainless steel cinch anchor bolts and hex nuts, allowing for vertical and radial adjustment.

2.12 FIBERGLASS REINFORCED PLASTIC FLAT TANK COVERS

A. Flat tank covers shall be per section 06 80 00 Glass-Fiber-Reinforced Plastic. The cover shall be fastened to the outer wall of the clarifier using 304 stainless steel cinch anchor bolts. The cover shall be supported with galvanized trusses installed outside the tank. Supports within the tank shall not be acceptable. The cover may also be supported upon the center bridge.

B. The design of the Flat Tank Cover shall be coordinated with the Primary Clarifier manufacturer to ensure proper fit upon receipt of materials.

2.13 PAINTING AND SURFACE PREPARATION

A. All non-submerged steel shall be sandblasted to The Society of Protective Coatings (SSPC)-SP-6 specifications and given one coat of manufacturer's epoxy primer 2-3 mils dry-film thickness (MDFT). All submerged steel shall be sandblasted to SSPC-SP-10 specifications and given one coat of manufacturer's epoxy primer 2-3 MDFT.

B. Prior to assembly of the drive unit, the castings shall have been sandblasted and thoroughly cleaned to remove any foreign particles in the drive base. After assembly, the drive mechanism shall be solvent cleaned and power wire brushed as needed prior to application of manufacturer's standard primer.

C. Gear motors shall be furnished with manufacturer's standard enamel.

2.14 SPARE PARTS

A. The intent of this specification is to provide uninterrupted operation for a minimum period of 2 years. To meet this objective the clarifier manufacturer shall supply any spare parts, excluding lubricants, that are required to meet this time frame. As a minimum, provide the following spare parts, per clarifier:

1. One sight glass for each main drive housing containing oil.

2. One set of neoprene skimmer wipers.

PART 3 EXECUTION

3.1 INSTALLATION

A. The equipment shall be erected in strict accordance with the manufacturer's recommendations. A 2-inch layer of grout shall be applied to the tank floor in strict accordance with the manufacturer's recommendations. Screed boards shall be supplied by the erecting contractor.

3.2 SERVICE

A. The equipment manufacturer shall provide a service representative properly trained in inspection and operation of the mechanism to approve the installation, certify that the torque settings of the drive overload protection device are correct, perform the torque test and instruct the owner's personnel on maintenance and operation.

B. Manufacturer’s representative field service requirements:

1. Two(2) 8-hour days.

2. Two(2) trips to jobsite.

3.3 TORQUE TEST

A. The clarifier mechanism shall be field torque tested. The purpose of the torque test is to verify the structural integrity of the mechanism structural steel design and center drive unit. The testing shall be carried out under the supervision of the equipment manufacturer's representative and as approved by the Engineer before the mechanism is accepted and placed into operation.

B. The torque test shall consist of securing the rake arms by cables to anchor bolts installed by the contractor in the tank floor at locations specified by the equipment manufacturer. A load shall be applied to the scraper arm in small increments by means of a ratchet lever and cylinder connected to the cable assembly. The magnitude of the applied load shall be measured by calculating the torque from the distance of the line of action of each cable to the center line of the mechanism. A reading shall be taken at the drive design torque.

C. The manufacturer's service representative shall verify that the alarm, motor cut-out, and backup safety motor cut-out switches are properly set and are in proper operation to protect the clarifier mechanism as specified.

END OF SECTION

SECTION 46 43 24 – SECONDARY CLARIFIER MECHANISM

PART 1 GENERAL

1.1 SUMMARY

A. This section includes: four (4) circular hydraulic type suction header, cage drive clarifiers. Three of them are existing clarifiers which will need the new center drive unit with torque control, new skimming mechanisms, new suction header, and realignment of the weirs. One is a new clarifier which will need a center drive unit with torque control, walkway and platform with handrail, stationary center influent column, influent dispersion well, center feedwell, cage, suction header and manifold, sludge collection arms with rake blades, scum skimmer support arm, scum skimmer(s), scum box, scum baffle, weir plate, anchor bolts, and all other appurtenances required or shown on the drawings.

B. The mechanism shall have two arms. One arm shall be capable of removing settled activated sludge solids from the tank floor through the suction header to the collection manifold and delivering to the sludge withdrawal pipe. The second arm shall be designed to effectively scrape the settled solids from the basin floor to the sludge withdrawal sump as shown on the drawings. The clarified effluent shall be collected uniformly by the peripheral launder. Surface scum shall be collected by the scum skimming equipment and discharged through the scum withdrawal pipe.

1.2 DEFINITIONS

A. Design Torque: Torque used to select size, strength, and type of materials and components for mechanism and drive system and at which or below will provide continuous 24-hour per day clarifier operation for period of not less than 20 years at design torque condition and rotational speed specified herein, without damage, permanent deformation or overload, and equal to 50 percent on overload device scale. Design Running Torque is applied at the output of the low speed final reduction unit.

B. Slenderness Ratio: Ratio of unbraced length to least radius of gyration.

C. Submerged Metal: Metal below gear head drive and a plane 18 inches above weir elevation indicated.

1.3 SUBMITTALS

A. Submit documentation in accordance with Section 01 33 00 – Submittal Procedures.

B. Two copies of all materials required to establish compliance with these specifications shall be submitted for review. Submittals shall include at least the following:

1. Certified general arrangement drawings showing all important details and materials of construction, dimensions, loads on supporting structures, and anchor bolt locations.

2. Descriptive literature, bulletins, and/or catalogs of the equipment.

3. Complete data on motors and speed reducers.

4. Wiring diagrams and electrical schematics for all control equipment to be furnished.

5. Calculations documenting the American Gear Manufacturers Association (AGMA) rating of the drive unit and life of the main bearing, prepared and signed by a registered professional engineer.

6. Complete descriptive information and electrical schematic for the torque overload device.

7. Complete process calculations substantiating the sizing of the center column and ports, influent dispersion well diffusers and outlets, and outer feedwell. These calculations shall be based on parameters from the manufacturers operating experience. These parameters shall be verified by data presented from successful operating installations.

8. Complete hydraulic calculations prepared and signed by a registered professional engineer. Calculations shall verify uniform sludge withdrawal over the tank bottom for the flow conditions stated in these specifications. Data at each orifice shall include orifice diameter, spacing, headloss, flow, and velocity in the header. Calculations shall be based on hydraulic data from full scale tests. Test data shall verify the choice of orifice and headloss coefficients along the suction header. Complete test data shall be available for inspection by the Engineer.

1.4 WARRANTY

A. The mechanism shall be warranted for 2 years from the time the mechanism is put into service. The drive main bearing shall be warranted for 10 years.

PART 2 PRODUCTS

2.1 MANUFACTURER

A. Clarifier equipment shall be manufactured by:

1. WesTech
2. ClearStream Environmental, Inc.

3. Ovivo, USA of Salt Lake City, Utah
4. Evoqua Water Technologies in Waukesha, WI

2.2 GENERAL REQUIREMENTS

A. Clarification equipment shall be the center drive type supported on a stationary influent column with the flow entering the bottom of the influent column and flowing upwards to the inlet openings at the water surface.

B. Settled solids shall be removed through the hydraulic suction header(s) to the collection manifold to the sludge withdrawal pipe. Settled solids shall also be removed through the use of a sludge collection sump as shown on the drawings.

C. Major Components of the clarification equipment shall include but not be limited to:

1. Center drive mechanism, gear motor, and overload alarm,
2. Walkway support with handrail and grating,
3. Center support/influent column,
4. Center drive cage,
5. Influent diffusion well,
6. Feedwell and supports
7. Suction header(s)
8. Collection manifold,
9. Sludge collection arm and rake blades
10. Skimmer support arm,
11. Scum skimmer(s),
12. Scum trough,
13. Weir plate and scum baffle,
14. Density current baffle, supports,
15. Fasteners and anchor bolts,
16. And all other components necessary for a complete operating system.

2.3 GENERAL DESIGN CRITERIA

A. Design flows

Equipment Name	Secondary clarifier 1 (existing clarifier) Secondary clarifier 2 (existing clarifier)	Secondary clarifier 3 (existing clarifier) Secondary clarifier 4 (new clarifier)
Equipment Number	CLA-450-01 CLA-450-02	CLA-450-03 CLA-450-04
Maximum inlet flow, MGD	2.2	4.2

Minimum inlet flow, MGD	0.8	0.8
Design inlet flow rate, MGD	1.6	2.8
Maximum RAS flow, MGD	0.55	1.05
Minimum RAS flow, MGD	0.4	0.72
Maximum headloss through header, ft	0.5	0.5
MLSS concentration range, mg/L	1000-5000	1000-5000

B. Equipment Design Criteria:

Equipment Name	Secondary clarifier 1 (existing clarifier) Secondary clarifier 2 (existing clarifier)	Secondary clarifier 3 (existing clarifier) Secondary clarifier 4 (new clarifier)
Equipment Number	CLA-450-01 CLA-450-02	CLA-450-03 CLA-450-04
Sludge collector diameter, ft	4-in WAS, 6-in RAS	4-in WAS, 6-in RAS
Sidewater depth, ft	12	15
Freeboard, ft	1.5	1.5
Floor slope, inch/ft	N/A	N/A
Influent column diameter, inch	14	18
Influent dispersion well diameter, ft	5.5	7
Influent dispersion well depth, ft	3	3
No. of diffuser gates of IDW	4	4
Feedwell diameter, ft	11	14
Feedwell depth, ft	6	5
Scum box width, ft	4	4

Rake arm tip speed, ft/min	8-12	8-12

C. Torque Requirements (foot-pounds)

a. Continuous Operating: 9,400
b. Maximum Overload: 17,500
c. Momentary Peak Load: 14,700
d. Mechanism Design Strength: XX

D. Drive Design Requirements:

1. Mechanism design shall be such that there are no chains, sprockets, or bearings below or in contact with the liquid.

2. Gearing shall be designed and rated per the current AGMA Standards.

3. Drive shall have a minimum operating life of 20 years at the continuous torque and speed rating listed above.

E. The walkway and platform shall be design for all deadloads plus a live load of 50 pounds per square foot. Deflection under full dead and live load shall not exceed 1/360 of the span.

F. Fabricated assemblies shall be shipped in the largest sections permitted by carrier regulations and properly match marked for ease of construction.

G. Fabricated and Structural Steel shall be per American Society for Testing and Materials International (ASTM) A36 standards

H. Minimum metal thickness shall be 1/4-inch for all submerged plate and members unless otherwise specified.

2.4 EQUIPMENT DESCRIPTION

A. DRIVE MECHANISM

1. General: The drive mechanism shall consist of an electric motor, primary reduction unit, and an enclosed final reduction unit consisting of a pinion and an internal tooth gear.

2. Primary Reduction Unit: The primary reduction unit shall be mounted on the top of the final reduction unit and properly registered to maintain accurate centers for the final reduction gearing.

a. The primary reduction unit shall have sufficient bearing capacity to fully support the pinion gear without a lower support bearing.

b. The L_{10} life of the primary gearbox bearings shall be in excess of 100,000 hours at the operating torque listed in the Equipment Design Criteria section.

c. The primary reducer shall be AGMA rated for 10 million cycles, when drive is operating at the continuous output torque listed in the Equipment Design Criteria section.

d. The primary reduction unit shall be coated with two-part epoxy paint for high corrosion resistance.

3. Final Reduction Unit:

a. The final reduction housing shall be manufactured from A36 steel plate. All welds shall conform to applicable specifications of the American Society of Mechanical Engineers (ASME). After welding, all mounting, and mating surfaces shall be machined to insure proper fit and alignment of the drive pinion and mating gear. The base plate on which the gear and bearing is mounted shall be flat within 0.005-inch.

b. The final reduction unit gear shall be machined to AGMA grade 6 or higher. Gear teeth shall have a core hardness of 250 to 300 Brinell hardness number (BHN), and be induction hardened to 55 Rc. The main gear set shall be rated per AGMA Standard 2001-C95 for 20 years at a continuous torque load of at least 9,400 foot-pounds. Gear pitch diameter shall be a minimum of xx inches.

c. The final reduction unit pinion shall be made of heat-treated alloy steel and shall be mounted on the output shaft of the intermediate reduction gearbox. The gear teeth shall be induction hardened to 55 to 60 Rc.

d. The bearing shall have a seal to prevent contamination of the bearing raceway. The bearing shall have a L_{10} life in excess of 100 years

4. Electric Motor: The drive motor shall be Mill & Chemical Duty, TEFC, 1.15 Service Factor, Class F insulation.

5. All lubrication shall be of the totally enclosed grease design.

6. Torque indication and overload protection:

a. The torque overload protection device shall be attached to the primary reduction unit and activated by the torque reaction of the primary reduction unit.

b. The torque load of the drive unit shall be indicated on a stainless steel 6-inch diameter torque gauge in foot-pounds.

c. The overload protection device shall have two switches, which may independently energize an alarm circuit and motor cutoff circuit when the load o the mechanism reaches the customer specified torque settings.

d. The switches shall be enclosed in a National Electrical Manufacturers Association (NEMA) 4X housing.

e. In addition to alarm and cutoff, the drive unit is also protected by a shear pin.

B. CENTER DRIVE PLATFORM

1. The center drive platform shall provide access to the center drive assembly, lubrication fill and drainpipes, drive torque control, and electric control panel.

2. The platform shall provide 30-inch clearance around the drive components. A removable section of the flooring shall provide access to the drive maintenance points.

3. The platform shall consist of aluminum grating supported by the platform bottom members. Handrail shall be 3– rail aluminum handrail.

C. BRIDGE WALKWAY

1. The walkway bridge shall be constructed of structural I-beams or two side structural trusses of welded steel with a 36-inch wide walkway consisting of aluminum grating supported by the walkway bottom members. Handrail shall be 3–rail aluminum handrail. In the case of structural truss construction, the side truss may serve as handrails for the walkway.

2. The bridge shall be supported by the center drive platform and the outer tank wall.

D. STATIONARY INFLUENT COLUMN

1. The influent column shall have a minimum 1/4-inch wall thickness with the diameter as listed in the Equipment Design Criteria.

2. The column shall be designed to support the weight of the entire structure resting upon it and to withstand the Mechanism Design Strength criteria.

3. Influent discharge ports shall be included at the upper end of the influent column. These ports shall diffuse the flow entering the tank and insure low velocity into the Influent Dispersion Well.

E. CENTER CAGE

1. The center cage shall be a steel box truss construction with connections for the sludge removal arms.

2. The cage top shall bolt to the main gear.

3. The cage shall be designed to withstand the Mechanism's Design Torque.

F. SLUDGE COLLECTOR MECHANISM

1. The sludge collection system shall consist of two sludge removal arms. One arm comprises of the sludge suction header and the collection manifold. The second arm consists of the rake arm and blades. The mechanism shall collect the sludge form the tank bottom and carry it through the header to the outlet manifold and to the opening of the sludge withdrawal pipe. The suction header shall collect the sludge through a series of inlet orifices and a fluidizing vane designed to sweep the entire tank bottom every revolution. The rake arm shall draw sludge to the center of the clarifier where it is deposited into a sludge collection sump. The handling capacity shall be as specified in the General Design Criteria.

2. The fabricated steel manifold shall encompass the center column and be rigidly connected to the drive cage. Seals between the manifold – center column and the manifold – tank bottom shall minimize leakage into the manifold. The inside bottom of the manifold shall be open and completely cover the opening to the sludge withdrawal pipe. The suction header and manifold shall connect by matching flanges.

3. The suction header shall consist of a rectangular shape tapering tube, varying in size from a minimum at the outer tank edge to a maximum at the connection to the manifold. Standard or fabricated incremental pipe sizes will not be acceptable for use in the sludge withdrawal header.

4. Orifices shall be variably spaced along the header and/or adjusted in size such the orifices withdraw a sludge volume proportional to their area of influence as the header sweeps the tank bottom. Orifices along the leading bottom edge of the suction header shall be spaced at no more than 30-inch intervals. It necessary a deflection blade shall be attached from the collection manifold to the header to mover the settled sludge to the first orifice. A 304 stainless steel 26-gauge adjustable squeegee shall be attached to the defector blade.

5. The suction header(s) shall be supported from the drive cage by steel tie bars to hold the header in vertical and horizontal alignment. The header shall be designed to withstand the higher of (1) a uniform load along the suction header that

produces the Mechanism Design Load, or (2) a point load applied at the outer end that will produce the Mechanism Design Load.

6. The longitudinal cross-sectional axis of the rectangular suction header(s) shall be mounted at an angle of 45 degrees with the tank bottom. The leading edge of the rectangular header(s) shall extend forward and down 2 inches at an angle of 45 degrees to provide an equalizing vane as an integral part of the header and direct the sludge into the orifice's area of influence. An adjustable neoprene squeegee shall be attached to the with a steel backer bar.

7. The header and manifold shall be constructed of 304 stainless steel.

8. Header shall be dielectrically isolated from rest of clarifier mechanism at connection flange and at other points of interconnection such as support rods.

9. The rake arm consists of steel truss construction with steel raking blades and adjustable 20-gauge, 304 stainless steel squeegees. The rake blades shall be properly spaced to insure complete raking of the basin floor once per revolution.

10. The cage and rake arms shall be designed such that calculated stresses do not exceed the American Institute of Steel Construction (AISC) allowable stress at twice the drive 100 percent rating.

G. INFLUENT DISPERSION WELL

1. A rotating circular Influent Dispersion Well shall be of the size indicated in the Equipment Design Criteria. It shall be supported by the cage and diffuse the liquid into the feedwell in a tangential direction through diffusers. The bottom of the well shall extend to within 1-inch of the center column.

2. The diffusers shall:

   a. be curved at a constant radius,
   b. not restrict the flow,
   c. extend pass the gate opening equal to the opening size, and
   d. have a bottom the length of the diffuser.

H. FEEDWELL

1. The feedwell shall be of the size indicated in the Equipment Design Criteria. It shall be supported by structural steel supports [attached the center cage] [attached to the rake arms]. The well shall be fabricated of 3/16-inch steel plate with top and bottom reinforcing angles.

2. The feedwell shall include four 4-inch by 12-inch adjustable scum port openings to allow escape of surface scum inside the well. A removable scum baffle shall be provided over the ports.

I. SURFACE SCUM SKIMMING EQUIPMENT

1. A skimmer support arm shall be attached to the cage opposite the suction header and support the scum deflector blade and the scum skimming mechanism. The skimmer support arm shall be designed to withstand the larger of (1) a uniform load placed along the support arm that produces 60 percent of the Design Mechanism Torque, or (2) a point load at the outer edge that produces 60 percent of the Mechanism Design Torque.

2. There shall be mounted on the skimmer support arm(s) (a) skimming device(s) arranged to sweep the surface of the of the clarification compartment once per revolution, automatically removing scum and floating material into a scum box at the tank periphery.

3. The rotating scum deflector blade(s) shall consist of a steel channel supported and extended tangentially form the feedwell to a recessed adjustable pivoted scum scraper at the tank periphery.

4. The scum scraper shall consist of aluminum scrapper, double acting hinged connection, support arms, neoprene wipers, outer wear strip, and a positive means to maintain the blade against the baffle.

5. The scum scraper shall trap floating scum pushed outwards by the tangential steel scum blade and efficiently deposit the solids into the scum trough.

6. The scum trough shall be the size indicated in the Equipment Design Criteria and constructed of 1/4-inch steel plate with a 6-inch outlet.

7. The clarifier equipment manufacturer shall furnish a flush valve assembly for automatic flushing of the scum box and scum pipe. The flush valve assembly shall allow approximately 2 to 5 gallons of clarified effluent to enter the box as the skimmer assembly passes over the scum box. It shall consist of an actuator bar and a pivoting assembly that will open a valve. A counterweight shall close the valve after the flush cycle ends.

J. WEIRS AND BAFFLES

1. The weirs, baffles and baffle supports shall be constructed of a minimum 1/4-inch Fiberglass Reinforced Plastic (FRP).

2. The contractor shall coat all joints and gaps between the walls and weirs with a silicone rubber sealant to prevent leakage.

3. Any cutting or drilling of the weir or baffle in the field shall be sealed per the manufacture's recommendations.

K. ANCHOR BOLTS AND FASTENERS

1. Anchor bolts shall be 304 stainless steel and be furnished the equipment manufacture. All fasteners to be 304 stainless steel.

L. SURFACE PREPARATION AND COATING

1. All fabricated steel to be:

   a. Non-submerged steel: Shop blasted per SSPC-SP6 (commercial blast and coated with 2 coats of high-build epoxy polyamide, 8-12 mils DFT and 1 coat of Acrylic Polyurethane, 3 to 5 mils DFT.

   b. Submerged Steel: Shop blast per SSPC-SP10 (near white) and coated with two coats of high-build polyamide epoxy, 12-16 mils DFT.

2. Drive mechanism shall be painted with the manufactures standard paint system

PART 3 EXECUTION

3.1 INSTALLATION

A. Furnish, install, finish, and place into service the clarifier in accordance with the manufacture's recommendation.

B. Provide factory-trained personnel to check and certify installation and instruct the plant personnel in the operation and maintenance. A minimum of one trip for 2 days total shall be provided.

END OF SECTION

SECTION 46 61 41 – DISK CLOTH FILTER

PART 1 GENERAL

1.1 SUMMARY

A. Furnish all labor, materials, equipment, and incidentals required for automatic backwash filter system as shown on the plans and as specified herein, installed, tested, and ready for operation.

B. Each Cloth Media Disk Filter shall consist of individual disks of the number required; a centrally located rotating shaft with vacuum shoe assemblies mounted thereto, 304 stainless steel swivel joints, filtrate pipes, drive mechanism complete with sprockets and non-metallic drive chain.

C. Filter system shall be designed for installation in a concrete tank as shown on the contract drawings/plans.

1.2 REFERENCE STANDARDS

A. ASTM – American Society for Testing and Materials
B. AISI – American Iron and Steel Institute
C. AGMA – American Gear Manufacturer's Association
D. NEMA – National Electrical Manufacturer's Association
E. NEC – National Electrical Code

1.3 QUALITY ASSURANCE

A. To assure unity of responsibility, all components of the disk filter system shall be supplied by a single manufacturer.

1.4 SUBMITTALS

A. Submit according to Section 01 33 00 – Submittal Procedures.

Submit dimensioned, to-scale drawings of equipment showing its proposed installation in this facility. Where piping, structural components, etc. are involved, drawings shall show clearly that the proposed equipment will fit into the plant design without significant modifications and will function as intended in conjunction with other plant items. Modifications to plant structures, piping, electrical, etc. shall be made at the Contractor's expense and only after approval by the Engineer.

B. Information required for approval by the Engineer prior to incorporation into the project shall include the following as a minimum requirement:

1. Certified dimension prints detailing all required anchor bolt locations and conduit stub-outs. Submit dimensioned to-scale drawings showing installation of screening equipment for this specific application.

2. Specifications for all electrical and mechanical components and complete wiring diagrams for all components.

3. Manufacturer’s standard Programmable Logical Controller (PLC) code for the complete disk filter system operation, in electronic format.

4. Manufacturer’s recommended procedures for jobsite storage and handling of equipment.

C. Operation and Maintenance Manuals: Prior to delivery of equipment and updated as required during installation of the equipment, the manufacturer shall furnish complete and detailed installation, operation and maintenance manuals which shall include the following information as a minimum requirement:

1. Assembly, installation, and adjustment instructions.

2. Lubrication and maintenance instructions.

3. Complete descriptive literature of all materials and components furnished.

4. Erection drawings with equipment mark numbers.

5. Complete operating instructions for controlling, modifying, and operating the equipment provided for this facility.

1.5 EXPERIENCE

A. It is desired that only equipment which has undergone thorough development as provided by successful service in at least 10 similar installations for a minimum of 10 years shall be accepted for this project. Manufacturers who do not meet the experience requirements shall not be acceptable. Bonds or cash deposits are not an option in lieu of experience.

1.6 WARRANTY

A. The equipment shall materially conform to the description in this Specification and the Contract Documentation and shall be free from defects in material and workmanship. The Supplier shall repair or replace defective parts without charge to the Owner. Warranty periods are 1-year from start-up.

B. Filter cloth media shall be warranted

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. The acceptable manufacturers (Supplier) and equipment models for consideration are:
   1. Five Star Filtration, LLC - Five Star Cloth Media Disk Filter
   2. Nexom
   3. Pre-Approved Equal

B. The drawings and specifications were prepared based on the Nexom cloth disk filter system. Contractor shall include in the Bid and shall be responsible for the cost of any changes, including engineering changes, to accommodate the other than Base Bid equipment, including but not limited to structural, mechanical and electrical work.

2.2 PERFORMANCE REQUIREMENTS

A. Equipment

Equipment Name	Tertiary Filter Unit 1	Tertiary Filter Unit 2
Equipment Number	FLT-510-01 (filter motor) PMP-510-01 (backwash pump)	FLT-510-02 (filter motor) PMP-510-02 (backwash pump)

B. Each disk filter unit shall be capable of meeting the following performance requirements while receiving treated domestic wastewater from a biological activated sludge secondary treatment process:

<u>PERFORMANCE CRITERIA</u>	<u>VALUE</u>
Average Daily Flow (ADF):	2,085 USgpm (3 MGD)
Peak Daily Flow (PHF):	8,611 USgpm (12.4 MGD)
Total filter area available (min.):	1146 ft^2
Filter Area flow rate (ADF):	1.6 to 1.8 gpm/ ft^2
Filter Area flow rate (PHF):	6.6 to 7.5 gpm/ ft^2
Filter Area flow rate (PDF) (1 disk offline):	7.5 to 8.6 gpm/ ft^2
Influent to Filters	TSS Average < 10 mg/L TSS Max < 20 mg/L
Effluent from Filters	TSS Average < 5 mg/L

FILTER DESIGN DATA	
Filter Cloth Material	Polyester, multi-layer
Number of Filter Units	2
Number of Filter disk per unit	8 to 9
Filter Disk Diameter, ft.	6 to 7
Effective Filter Surface Area per unit, ft^2	573

FILTER DRIVE UNIT	
Drive Motor (1 per unit)	0.5 HP, 480v, 3 phase, 60 Hz
Drive Motor Service Factor	1.3
Backwash Arm Rotational Speed, RPM	1.1
Materials of Construction	304 SS and plastics Parallel Helical Gear w/Non-Metallic Chain and Sprocket

BACKWASH CLEANING SYSTEM	
Number of Backwash Vacuum Shoes per Disk	2
Backwash Pumps (1 per unit)	7.5 HP, 480, 3 phase, 60 Hz.
Backwash Flowrate, gpm	500 @ 15' TDH
Backwash Flow, % of Influent	< 2% @ PF(2Hr)

C. The automatic backwash disk filter system shall be suitable for filtering domestic wastewater after conventional treatment. Each filter shall be designed to operate on a continuous basis at Peak Flow Rate and shall be designed to operate while receiving varying flow rates.

D. Each disk shall be isolatable, one from the other. Each disk shall be removable without dewatering the filter tank or taking unit out of service.

E. Cloth media disk filter must provide for redundancy by accommodating 100 percent of Peak Flow with one disk out of service while continuing to meet effluent quality requirements.

F. Filter designs that have an inside-to-outside flow pattern are not acceptable.

2.3 COMPONENTS

A. Manufacturer to provide:

1. Filter cassette (304 stainless steel)

2. Filter disk modules (304 stainless steel) with filter grid and cloth media

3. Center vacuum tube assembly complete with 2 vacuum shoes per disk

4. One drive unit, motor, drive sprocket, and chain with guards for each filter basin

5. Isolation valves for each disk

6. Two (2) backwash pumps and motors designed for continuous duty and long operation life in a high humidity atmosphere.

7. Four (4) backwash valves and two (2) sludge valves with 316 stainless steel valve stems.

8. Six (6) electrically valve actuators with NEMA Type 4x weatherproof enclosure and visual position indicator. Actuator shall include separate control and power conduit entries. Drive mechanism shall eb permanently lubricated.

B. All welding shall conform to the latest standards of the American Welding Society. Filter cloth shall be multi-layered polyester bags with seal arrangements to allow for easy removal and installation. Cloth media that requires bolting to hold it in place is unacceptable and is not allowed. Filter cloth support grid shall be non-metallic and have a deflection of less than 0.25 inches over the entire 6-foot span of the disk.

2.4 EQUIPMENT

A. Filter Tank and Internal Components

1. The filter tank shall be constructed of concrete.

2. All structural shapes shall be designed for the intended use and of adequate strengths to withstand all loads during fabrication, shipping and operations.

3. Each filter tank shall incorporate one inlet nozzle with an influent trough designed to evenly distribute the flow across the width or length of the filter tank.

4. The filter tank shall incorporate one effluent nozzle connected to a filtrate trough designed to remove the entire flow of the filter tank.

5. The filter tank shall have an overflow weir connected to the effluent trough for emergency bypass or overflow.

6. The filter system shall have two backwash nozzles connected to a center rotating backwash manifold within the tank. The backwash manifold shall be constructed of 304 stainless steel. Each end of the center rotating backwash manifold shall be connected to a 304 stainless steel swivel joint bearing designed for submerged service. The filter tank shall incorporate a drain/sludge removal port with a

minimum 3-inch nozzle. Inside the tank shall be a perforated drainpipe sized adequately and designed to evenly remove settled sludge from the filter tank.

B. Filter Disk

1. The filter disk frame shall be constructed entirely from Type 304 stainless steel as an integral unit completely welded and supported for all operating and installation loads.

2. Each disk shall have grid support structure incorporated into the disk frame and it shall be designed to secure the grid in place and minimize wear to the filter cloth bags.

3. Each disk shall have a single top mounted effluent pipe adequately sized for the application and shall include a lifting eye for easy removal and placement of the one-piece disk assembly.

4. Each disk shall be attached to the effluent trough independently to allow disk isolation. Only one wall connection point per disk shall be allowed. The disk filter design shall insure the ability to sample filtrate from each disk independently. Each disk shall have a knife gate valve for complete isolation and shutoff while the disk is removed from operating filter.

5. Designs that do not incorporate a complete isolation by means of a valve on each disk are not acceptable.

C. Support Frame

1. Each disk shall be secured in place in the filter tank by a 304 stainless steel guide frame. The guide frame shall be designed to withstand all loads of the disk and the rotating shaft assembly.

2. The frame designed to maintain the disk location in the center of the filter tank and directly above the rotating backwash manifold assembly.

3. Each vertical frame member shall be flared 15 degrees to minimize damage to the filter disk and cloth as it is being installed and removed from the frame.

D. Rotating Backwash Assembly

1. Each filter unit shall incorporate a centrally located rotating backwash manifold that will operate as the rotating mechanism for the vacuum shoe assembly and also act as the transmission pipe for the backwash water being drawn by the backwash pumps located externally to the filter tank.

2. The center shaft/backwash manifold shall be constructed from 304 stainless steel pipe.

3. The center shaft shall be supported and secured on each end. Each end of the center rotating backwash manifold shall be connected to a 304 stainless steel swivel joint with a permanently lubricated bearing designed for submerged service.

4. The backwash manifold/rotating shaft is welded to a sprocket hub constructed of 304 stainless steel with a ultra-high-molecular-weight (UHMW) split-ring sprocket designed for the rotational speed requirements of the application.

5. Each vacuum shoe (two for each filter disk) shall ensure that the shoe is parallel to the disk face. The filter backwash shoe shall have minimal contact with the cloth media across the entire suction zone so as to reduce wear on the cloth media and reduce solids impingement in the cloth media.

6. Each vacuum shoe assembly shall be located 180 degrees from the shoe on the opposite side of the same disk.

7. Filter designs that utilize a horizontal vacuum tube, coupled to a 4-point lifting device to vertically raise and lower the backwash header is not acceptable. With no adjustment between the backwash manifold and the cloth media surface, damage may occur to the cloth or uncontrolled wear will occur making this design unacceptable. Designs that incorporate reversed gravity flow and compressed air to backwash the cloth are unproven and unacceptable. Designs that require that the shoe does not have any contact with the filter cloth media are ineffective and not acceptable.

8. Filter designs that utilize a non-rotating cleaning design with four non-rising shafts are not acceptable.

9. Filter design that utilize a flexible hose to connect to the vacuum cleaning mechanism are not acceptable.

E. Swivel Joints

1. The swivel joints shall be designed to allow rotation of the backwash assembly and center shaft during the backwash cycle.

2. Construction of the swivel joint shall be 304 stainless steel with a permanently lubricated bearing designed for submerged service. Stainless steel shafts shall be precision ground with the machined bearing to insure a precise tolerance.

F. Drive Mechanism

1. The drive assembly shall be designed to rotate the backwash assembly and center shaft during the backwash cycle.

2. The drive assembly shall consist of a parallel helical gear drive unit coupled to the shaft with a shear-pin sprocket and a nylon chain assembly with stainless steel pins or a non-metalic chain and sprocket.

3. The gear motor shall be a SEW Eurodrive or AGMA gearbox directly coupled to a totally enclosed, fan-cooled (TEFC) induction motor.

4. Reducer design end rating shall be equal or exceed AGMA requirements. Speed reducer shall be selected for not more than AGMA class I service.

5. Drive chain shall be NH78 non-metallic with stainless steel pins.

6. Drive sprocket shall be a NH78, 11-tooth shear pin sprocket assembly, 9.26-inch pitch diameter (PD), nylon body with UHMW segmental rim, 304 stainless steel hardware and 6061 aluminum shear pins.

7. Reduction sprocket shall be a NH78, 54-tooth segmental sprocket rim, split UHMW.

8. The drive motor assembly shall be mounted on a 304 stainless steel motor bracket that incorporates adjustable placement capabilities and a removable chain guard.

9. Units that incorporate a 4-point vertical lifting design are not acceptable.

G. Backwash Pumps

1. The backwash pump(s) shall be Gorman-Rupp or WEMCO Wehr self-priming centrifugal pumps mounted on a fabricated steel base and coupled to a 5-horsepower, 1800 revolutions per minute (RPM), 460/3/60, TEFC Electric Motor.

2. Design duty condition: 500 gallon per minute (GPM) at 15 feet total dynamic head (TDH)

3. Pump shall handle 2-inch solids.

4. Pumps shall have 4-inch suction and 4-inch discharge flanges.

5. Pumps shall be provided with a 5-year manufacturer's warranty.

6. Each backwash pump shall be provided with a cast iron/ductile flanged check valve mounted on the discharge side of the pump to prevent backflow through the pumps.

H. Automatic Backwash Control Valves

1. The backwash valves shall be Asahi or Bray Series 31 Electric Actuated Butterfly Valve.

2. Valves shall be 115 volts alternating current (VAC) operated and controlled by the PLC.

3. Valves shall have manual override and position indicator.

4. Valves shall be UL Listed and housed in a NEMA 4/4X enclosure and be permanently lubricated with a mechanical brake.

5. Valves shall move from fully closed to fully open in 25 seconds and have a stall torque of 300 inch-pounds with a 25 percent duty cycle. Thermal overloads shall be included.

2.5 CONTROLS AND INSTRUMENTATION

A. Main Control Panel: No control panel shall be provided by the disk filter manufacturer. Contractor will provide wiring, control at the plant SCADA level.

B. Instrumentation: Each filter unit shall have a separate level transmitter that is provided, installed, and field wired by Contractor. No instrumentation shall be provided by the disk filter manufacturer.

C. Disk filter Manufacturer shall submit the Manufacturer's standard PLC code for the complete filter system operation, in electronic format, as required in Paragraph 1.4.B.

PART 3 EXECUTION

3.1 INSTALLATION

A. General

1. Install the disk filter system per the manufacturer's directions and the drawings. Provide all supports and anchoring device required to install the disk filter unit. The Equipment Manufacturer will provide adequate crating and protection of the disk filter equipment for shipment to the project site.

2. Installation Instructions will be provided that specifically outline installation of the equipment.

3. Lifting instructions will be provided to assist the installing contractor.

B. Field Services: The equipment manufacturer shall furnish the service of a factory-trained representative for 2 working days and one trip.

END OF SECTION

SECTION 46 66 56 – OPEN CHANNEL ULTRAVIOLET DISINFECTION EQUIPMENT

PART 1 GENERAL

1.1 SUMMARY

A. This section covers the work necessary to supply, program, deliver, and commission a low pressure-high output (LPHO) Ultraviolet (UV) disinfection system, including but not limited to the following components: UV lamps, UV lamp sleeves, UV lamp holders, UV racks/modules/banks, UV intensity monitoring instrumentation, UV transmittance monitoring instrumentation, power supply units, isolation transformers, cables, UV master control panel, lamp ballasts, UV control and instrumentation system, automatic cleaning system, channel isolation and level control devices, lifting equipment, safety equipment, and spare parts for each of two UV disinfection channels.

B. All equipment and products supplied in this Section shall conform to Section 46 05 13, General Requirements for Equipment.

1.2 DEFINITIONS

A. The following terms are used in this Section and shall be interpreted as described:

1. Bioassay: A biological test used to assess the effectiveness of UV disinfection for the inactivation of microorganisms.

2. Design Ultraviolet Dose: The delivered UV dose required to meet the required effluent concentration for E-coli. The design UV dose is used for sizing UV disinfection systems. References to the design dose shall indicate the Reduction Equivalent Dose based on the use of MS2 bacteriophage as the indicator organism.

3. Lamp Aging Factor: The reduction in available UV output at the end of UV lamp life as compared to a new UV lamp, after the appropriate burn-in period.

4. Lamp Sleeve Fouling Factor: The reduction in available UV output due to changes in transmittance of the enclosure (such as, quartz sleeve) separating the UV lamp from the liquid. The reduction in the available UV output is determined by comparison to a new enclosure.

5. Head Loss: Loss of energy caused by friction or turbulence induced by appurtenances in pipes, equipment, and open channels.

6. Performance Testing: A procedure whereby the performance of the UV equipment system is confirmed.

7. UV Intensity Sensor: A device used to measure the intensity of UV radiation striking a UV sensor within a UV reactor.

8. UV Transmittance (UVT): The ability of a fluid to transmit UV radiation. UV transmittance is quantified by spectrophotometric measurement at a wavelength of 253.7 nanometers (nm) using a 1-centimeter (cm) path length.

9. Supplier: The manufacturer of the UV Disinfection System.

10. System: The entire UV disinfection system including but not limited to the lamps, sleeves, wipers, modules/banks (including integrally installed instrumentation), PDCs, UV sensors and analyzers, flow control gates, and Control Panels. The System shall be a fully functional package capable of performing the specified process operations and including all components necessary for proper operation.

11. UV Lamp: An amalgam LPHO lamp designed to produce light output within the desired ultraviolet wavelength range.

12. UV Lamp Sleeve: A quartz enclosure designed to separate the UV lamp from the liquid flow stream.

13. Ballast: An electronic device used to condition power fed to the UV lamps.

14. UV Rack/Module: An assembly containing a number of UV lamps designed to function as a process and electrical unit. Each channel shall contain an identical number of UV racks/modules.

15. UV Bank: An assembly containing a number of UV racks/modules designed to function as a unit. Each channel shall contain an identical number of UV banks.

16. UV Channel: The UV channel shall consist of more than one UV bank in series, designed to operate with similar units to perform the process operation. Each bank shall include lamps installed in either a horizontal, inclined, or vertical configuration.

17. SCC: The UV System Control Center shall include programmable logic controller (PLC) integration of all signals and logic to provide fully automated control of the System. All System input and output shall be passed through this centralized control system.

18. PDC: Power Distribution Center shall be provided for each bank or channel (as required) to power the components in each channel (such as, lamp ballasts, wipers, instrumentation, etc.).

1.3 SUBMITTALS

A. General: Administrative, shop drawings, samples, quality control, and contract closeout submittals shall conform to the requirements of Section 01 33 00, Submittal Procedures. All submittal dimensions, calculations, and other information shall be in English units of measure.

B. Action Submittals: Shop Drawings and Product Data:

1. List mechanical components of System and provide complete catalogue information, descriptive literature, specifications, and identification of materials of construction, including spare parts.

2. PDF drawings showing piping and instrumentation diagrams (P&IDs), plan layout, cross-sections, dimensions, critical clearances, installation requirements, and all interconnections and interface requirements (power, controls, instrumentation, and etc.).

3. Provide all UV equipment weights (dry and wet) and equipment anchoring and installation criteria.

4. Description of how equipment incorporates flow, UV intensity sensor, lamp age, fouling factor, and UVT analyzer readings into dose pacing calculations and all available modes of operation.

5. Description of level control devices to be provided.

6. Hydraulic calculations for head loss starting downstream of the inlet channel gates through the UV lamps up to the effluent gates.

7. Complete description of UVT analyzers and UV intensity sensors. Include operation and maintenance requirements. Include information regarding reading accuracy and reading stability.

8. Descriptive information on ballast and sleeves, including type of ballast, number of power levels, minimum power setting, acceptable number of cycles per day, type of quartz in sleeve, data on absorbance by the sleeve material.

9. Detailed information on the automatic cleaning system and description of cleaning system components and intended operation.

10. Description of possible power settings for a given rack/module/bank and percent turndown range and graph showing input power required to provide equivalent output versus hours of use.

11. Graph of power draw versus dose from 20 to 35 megajoule per square centimeter (mJ/cm^2) MS2 RED at 55 percent UV transmittance, based on validated test results.

12. Graph of the delivered MS2 RED based on UV transmittance values between 50 and 64 percent, in increments of 2 percent, at full power and end of lamp life/fouled sleeves.

13. PDC and SCC descriptive information, panel drawings, and wiring diagrams.

14. Detailed control philosophy, description of components, list of inputs/outputs (I/O), list of alarms and classifications, preliminary PLC programming logic, and integration into the overall Plant control system (SCADA).

15. Transformer descriptive information and ratings.

16. Electrical interconnection diagrams including electrical wiring between ballasts, isolation transformers, PDCs, SCCs, and the UV lamps.

17. Specifications for all interconnecting cables between the UV equipment including voltage ratings, insulation type, conductor material and cable/conductor outside diameter, maximum cable length, and cable terminator type and quantity.

18. Routine and preventative maintenance schedules, including specific lifting and access requirements.

19. Recommended shipping method, handling method, requirements for storage and protection, prior to and after installation. A list of all replaceable system components along with their expected replacement frequencies, duration of life warranties, guaranteed replacement prices, and calibration frequencies.

20. Include a list of special tools, equipment, and materials not provided by the UV supplier that are required for checking, testing, parts replacement, and maintenance.

C. Informational Submittals:

1. Test plans shall be submitted to and approved by Engineer at least 14 days prior to starting the testing. Test reports shall be submitted to Engineer within 20 days after completing the testing.

2. List of UV System installations including location, maximum flow rate, design dose, design UVT, effluent water quality requirements, number of channels/banks/modules/lamps, starting date of operation, and reference contact information.

3. Detailed report of validation testing with third party signature, raw data, and documentation of all reactor performance validation testing. Procedures shall conform to the “Uniform Protocol for Wastewater UV Validation Applications” as published July 2011, by the International Ultraviolet Association (IUVA) manufacturers’ council. All procedures shall conform to the National Water Research Institute (NWRI) Ultraviolet Disinfection Guidelines for Drinking Water and Water Reuse, either Second Edition (May 2003) or Third Edition (August 2012), for MS2 bioassays.

4. Additional Third-Party Certification to Confirm:

   a. Lamp aging factor and fouling factor.
   b. Hydraulic head loss calculations.
   c. Power calculations.
   d. Harmonic analysis.

5. Factory Quality Control Submittals:

   a. Factory Test Plan.
   b. Factory Test Report and Manufacturer’s Certificate of Compliance.
   c. Software Documentation.

6. Operations and Maintenance (O&M) Manuals.

7. Field Quality Control Submittals:

   a. Component Test Plan.
   b. Component Test Report and Certificate of Proper Installation.
   c. Performance Test Plan.
   d. Performance Test Report and Certificate of Proper Performance.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Vertical, angled, and horizontal configurations that have been validated for the design conditions specified herein are all acceptable. The acceptable manufacturers (Supplier) and equipment models for consideration are:

   1. Trojan UV; Signa
   2. Wedeco, a Xylem brand; Duron
   3. Or approved equal

B. The drawings and specifications were prepared based on the Trojan UV Signa system. Contractor shall include in the Bid and shall be responsible for the cost of any changes, including engineering changes, to accommodate the other than Base Bid equipment, including but not limited to structural, mechanical and electrical work.

2.2 GENERAL

A. All components of the UV disinfection system shall be supplied by one responsible manufacturer (Supplier).

B. The System shall be able to provide continuous disinfection at peak hour flow with all equipment in service, at the end of lamp life, with fouled sleeves, and at the minimum design value of UV transmittance.

C. The System shall be designed to meet the design dose (MS-2 RED) of 30 mJ/cm^2.

2.3 MATERIALS OF CONSTRUCTION

A. All metal components in contact with wastewater flow shall be Type 316L stainless steel.

B. All other stainless steel components shall be Type 316L stainless steel.

C. All wiring exposed to UV light shall be Teflon coated, or otherwise protected from UV radiation effects.

D. All quartz sleeves shall be Type 214 clear fused quartz.

E. Any other materials used which are exposed to UV radiation (254 nm) must be Type 316L stainless steel, Teflon, or other suitably UV resistant material unaffected by prolonged exposure over the component's life.

F. All stainless steel welds must be pickled and passivated.

2.4 SYSTEM DESIGN CRITERIA

A. Provide a LPHO, UV disinfection system to be installed in two open channels. Two channels shall be capable of providing the specified level of disinfection at the peak hour flow, 12 MGD.

B. If a stilling or baffle plate is required in each channel for flow dispersion, it will be designed and provided by the same supplier as the UV Disinfection System. It shall induce no more than 6 inches of head loss at peak hydraulic conditions (6 mgd).

C. The System design characteristics are summarized in Table 1.

Table 1 Design Criteria

Parameter	Unit	Value

Average Daily Flow	mgd	1.8
Peak Hour Flow	mgd	12
Number of Channels	--	2 (each capable of treating a maximum flow of 6 MGD)
Wastewater Treatment Process (upstream of UV System)	--	Primary treatment, aeration basin, secondary clarification
Disinfection Limit (daily geometric mean)	# E. Coli/ 100 mL	126
Disinfection Limit (any single sample)	# E. Coli/ 100 mL	406
Minimum UV Transmittance at 253.7 nm	% per cm	65
Minimum UV Design Dose	mJ/cm^2	30
Lamp Age Factor	--	Maximum of 0.95*
Lamp Sleeve Fouling Factor	--	Maximum of 0.95*
Maximum head loss from the exit of the channel inlet gate through the UV lamps up to the effluent weir	in	6
*To be proven based on third-party data. In the absence of third-party certification, a combined aging/fouling factor of 0.7 must be used. Supporting test or lamp supplier documentation shall be provided to justify the actual value selected.		

2.5 GUARANTEED PERFORMANCE REQUIREMENTS

A. Effluent from the System shall have E. Coli not exceeding the levels specified in Table 1 under the influent conditions specified.

B. The maximum head loss at peak design flow through the entire System shall be not more than shown in Table 1. The calculated head loss shall be the difference in water level between the exit of the channel inlet gate and the level just upstream of the level control weir and confirmed by field measurement data gathered during Performance Testing.

C. Water level shall be maintained by the manufacturer's effluent level control gate or weir at the manufacturer's required level above the top row of lamps in the channel (for horizontal lamps) or above the top of the germicidal arc length (for vertical and inclined lamps) for the full range of channel flow rates from minimum to maximum. For both horizontal and vertical lamp systems, water level controlled by the effluent motorized gate shall not vary more than plus or minus 1/2-inch from the control level at any flow rate up to the design peak flow.

D. The UVT monitor shall automatically track the transmittance of the influent water at the 253.7 nm wavelength. Monitoring of influent water flow stream shall be continuous and flow-through. The System shall be furnished with an automatic calibration sequence. UV transmittance shall be measured from 40 to 100 percent, in increments no larger than 0.1 percent UVT. The on-line monitors shall incorporate a display screen for visual trend analysis on a 60-minute or 24-hour basis.

2.6 MATERIALS

A. Ultraviolet lamps shall meet the following requirements.

1. LPHO, Amalgam: Each lamp shall produce UV light with at least 90 percent of the UV emission at 253.7 nm wavelength.

2. The filament of the lamps shall be the clamped design, significantly rugged to withstand shock and vibration.

3. The electrical connections of the UV lamps at one end shall be through a non-proprietary pigtail with molded two-wire connector or polytetrafluoroethylene (PTFE) four-pin connector.

4. Lamps shall not produce any ozone.

5. The lamp supports shall be of a durable construction resistant to UV light.

6. The lamp design shall prevent electrical arcing between electrical connections in moist conditions.

B. UV Lamp Sleeves: The UV lamps are to be protected from contact with the treatment stream by a Type 214 clear fused quartz with a minimum of 90 percent transmission of UV radiation at the 253.7 nm wavelength and have a nominal wall thickness no greater than 2.0 millimeters.

C. Ballasts:

1. The ballasts shall be of the solid state, electronic type and specifically designed for the lamp. Ballast shall supply lamp output recommended by the lamp manufacturer.

2. The UV lamp ballasts shall be located within the PDC ballast enclosures. If located remotely from the channels, the ballast enclosures shall be capable of installation

at a distance from the UV banks that does not impact the overall facility layout. Maximum distance limitations shall be considered as part of the System evaluation criteria.

3. The electronic ballast shall comply with the following requirements:

   a. The ballast shall be specifically designed to power one or two UV germicidal low-pressure high output lamps.

   b. Separate ballast enclosures, if used, must meet the National Electrical Manufacturer's Association (NEMA) classification.

D. UV Module:

1. Each UV module shall consist of UV lamps mounted on a Type 316L stainless steel frame.

2. Each lamp shall be enclosed in its individual quartz sleeve, which shall not be subject to degradation over the life of the system.

3. The UV Modules shall be designed such that the Owner can change the lamps and quartz sleeves. Lamps shall be removable with the quartz sleeve and wiper system remaining in place.

4. The UV Module design and mounting shall enable non-technical personnel to carry out lamp replacement, wiper insert replacement, etc. without the need for any special tools or specialist isolation procedures.

5. All wires connecting the lamps to the ballasts shall be rated for exposure to UV light and the process stream or enclosed inside the frame of the UV Module.

6. Each UV Module shall be individually removable using a lifting mechanism provided by the Supplier or shall be equipped with lifting lugs so that they can be easily lifted with a standard hoist.

   a. If a mechanism for lifting the module from that channel is provided that is driven by an electric motor, the alternating current (AC) motor shall be manufacturer standard and shall conform to NEMA MG 1.

   b. If a mechanism to lift an individual module from a channel is included as a part of the UV system, it shall be designed so that no other lifting mechanism is required.

7. Ultraviolet lamps, electronic controls, and individual electronic lamp controllers/ballasts shall be arranged so that they may be easily tested in place.

8. Each UV Module may be equipped with flow dispersion baffles to create better mixing and more uniform UV intensity field within the reactor as long as the maximum head loss requirements herein are not exceeded, and as long as the System was also validated with the baffle in place. If validation was completed with a baffle, then the baffle must be provided to match the validation results.

   a. The baffles shall be an integral part of the UV Module.
   b. The baffle material shall be Type 316L stainless steel.

9. Provide an automatic mechanical or chemical/mechanical in-situ lamp cleaning system.

   a. The cleaning system will be fully operational while UV lamps are submerged in the channel and energized.

   b. The automatic cleaning system can be operated in either manual or automatic mode.

   c. The automatic cleaning system shall be controlled by the SCC for fully automatic operation.

   d. The time between cleaning cycles shall be factory preset based on design condition and shall be operator adjustable from the SCC/SCADA System based on operational necessity.

   e. If an electrically driven system is provided that includes an AC motor housed in the module, the AC motor shall be manufacturer standard and shall conform to NEMA MG 1.

   f. Mechanical Wipers:

      1) Wipers shall be fabricated of UV resistant material and installed in a manner which accommodates any irregularities associated with the quartz sleeves and precludes any binding during operation.

      2) The wipers shall be replaceable without having to dismantle the wiper drive system, complete removal of the quartz sleeves, or disassembly of the module structure.

      3) The wiper system shall travel the full length of the UV lamp sleeves.

10. Horizontal UV Module:

   a. Metal racks shall be provided for supporting the lamps in the channel. A self-supported rack frame shall be provided to hold the UV lamp racks when out of the channel to facilitate ease of maintenance.

b. An overall rack frame shall be Type 316L stainless steel and be suspended above channel by means of slotted stainless steel angles allowing adjustment to the precise height of the channel and requiring no fastening of the individual UV lamp rack.

c. The UV lamp rack shall be designed with reflector panels between module assemblies so that no ultraviolet light shall radiate above the channel.

11. Vertical UV Module:

a. The lid shall include individual latches and clamp against an internal gasket. Four support legs shall connect the module enclosure to a bottom pan.

b. Automatic interlock protection will be incorporated into each module enclosure such that with the opening of the module enclosure lid power to the lamps will be automatically shut off.

12. Inclined UV Module:

a. Each UV module shall be equipped with an interlock switch, which will automatically disconnect power to its associated UV bank if the module is raised from the UV channel or the quick disconnect plug is removed.

b. The lamp socket shall be centered against the inside of the quartz sleeve and shall be retained by a cap nut with a ribbed exterior surface providing a positive handgrip for tightening/loosening without the need for any special tools. This connection includes a self-contained O-ring, sealing the lamp and socket module (independently from the quartz sleeve).

E. Motorized Gates and Operators:

1. UV System shall include outlet level control gate or weir provided by Supplier. Channel inlet isolation gates will not be provided by the Supplier.

2. SCC PLC will be programmed to send an open/close signal to the channel inlet isolation gate (not provided by Supplier) and to receive a feedback position.

3. The operation of all gates shall be controlled by the SCC and shall relay status to the plant SCADA system.

4. Outlet Level Control Gates (if used):

a. The outlet level control gate shall be rising stem, self-contained, downward acting weir gate type with invert "P" seal for embedded side frame mounting in concrete structures.

b. Materials: Stainless Steel Construction:

   1) Plate, Sheet, and Strip: ASTM A240/A240M, Type 316L.

   2) Bars and Shapes: ASTM A276, Type 316L.

c. Gate Manufacturers:

   1) Whipps, Inc.

   2) Hydro Gate Corp.

   3) Rodney Hunt Co.

   4) H. Fontaine, Ltd.

5. Electric Outlet Level Control Gate Operators (if used):

   a. General:

      1) Operator components: Withstand a minimum of 250 percent of design torque or thrust at extreme operator positions without damage.

      2) Controls integral with actuator and fully equipped as specified in American Water Works Association (AWWA) C542.

      3) Size actuators to 1-1/2 times required operating torque. Motor stall torque not to exceed torque capacity of gates.

   b. Twenty-eight-inch-high direct yoke-mounted, totally enclosed weatherproof electric drive unit, and a totally enclosed gear box that operates a two-piece, bronze stem nut, which lifts the gate stem.

   c. Gears: Heat treated alloy steel, supported throughout by antifriction ball or roller bearings and grease lubricated.

   d. Automatic double-acting geared limit switches and double-acting torque switches.

      1) Gear directly to the operating gear train and shall be "in step" at all times, whether in motor or manual operation.

      2) Wire geared limit switches internally to stop the motor at the fully OPEN and fully CLOSED positions.

      3) Wire torque switches internally so that, in the event of a mechanical overload in either direction, the motor will be stopped.

e. Equip with side mounted handwheel for manual operation.

1) Include an automatic clutch to positively disengage the handwheel at any time the drive motor control is energized.

2) Design handwheel operator so that failure of the motorized gearing will not prevent hand operation of the gate.

6. Outlet Level Control Gate Drive Unit (if used):

a. Totally closed, non-ventilated (TENV), 480-volt, 3-phase electric motor per NEMA MG 1, with integral OPEN/STOP/CLOSE weatherproof pushbuttons, reversing controller, 120-volt control power transformer, space heaters in the limit switches and in the control compartments, mechanical dial type position indicator, and transparent plastic pipe stem cover and cap.

b. Furnish motor enclosure with drainage and breathing holes.

c. Self-locking, with approximately 12 inches per minute gate travel speed, and a rated running torque equal to 20 percent of the motor starting torque at a rated running time of 15 minutes, without exceeding the allowable NEMA temperature rise for the insulation class used.

7. Operation: Drive the gate to its fully OPEN or CLOSED position when the OPEN or CLOSED pushbutton is depressed momentarily. Motor shall stop in mid-travel when the STOP button is depressed.

8. Outlet Level Control Gate Controls (if used):

a. All control features listed above for Inlet isolation gates.

b. Continuous position output: provide transmitter to generate a 4-milliamp (mA) to 20 mA direct current (DC) signal to an external loop in direct proportion to gate position; the transmitter shall be factory mounted in a NEMA 250, Type 4 enclosure. Transmitter shall be capable of driving an external load impedance of 350 ohms minimum.

c. AC motor with solid state reversing starter and built-in overload protection. Controller capable of 1,200 starts per hour for modulating service.

9. Outlet Level Control Gate Actuator Manufacturers (if used):

a. Rotork Controls.
b. AUMA.
c. Flowserve Limitorque.

F. Electrical:

1. The Supplier shall be responsible for providing a 480-volt Delta- WYE/3-phase/60-hertz/isolation transformer, as required for UV system. Secondary voltage shall be determined by the Supplier. The Supplier shall determine size and quantity required for their proposed system.

2. Each rack/module shall be fitted with water resistant Underwriters Laboratories (UL) rated multipin connectors for power and data. Combined power and data shall not be acceptable.

3. Each module shall plug into a PDC via a multi-conductor cable and molded connector provided by Supplier. There shall be at least one PDC that will distribute power and relay monitoring data and control for each Channel. Each module in the vertical system shall be isolated via two rectifier cards that each feed a ballast rack.

4. Each PDC shall be powered through an isolation transformer, provided by the Supplier, to provide the correct voltage required by the equipment. The transformer shall have a 480-volt, 3-phase, 3-wire (plus ground) primary and shall be sized to handle the power requirements of the equipment. Each PDC shall be mounted on elevated supports or housekeeping pads.

5. The SCC shall provide monitoring and control of all the UV lamps. Power to the SCC shall be 120-volt, single-phase, 60-hertz or as required by the Supplier. In no case will power be supplied above 480 volts. The SCC shall be connected to each PDC and plant SCADA via EtherNet/IP communications. The communications cable shall be as recommended by the Supplier.

6. PDC: Data concentration shall be through integrated circuit boards located inside the PDCs. Circuit breakers and ground fault circuit interrupters (GFCI) shall be located inside the PDC and be capable of being reset and tested locally at the PDC. Visual confirmation of a tripped GFCI shall be provided.

7. The wiring within the PDC must be properly isolated for proper ventilation to prevent damage to wiring.

8. Integral or chain-connected waterproof caps shall be provided for all multipin connectors.

9. The UV rack/module connectors shall be watertight with a molded back shell and meet the requirements of UL 574 for direct water jet spray when mated.

10. All electrical power terminals shall be rated for 75 degrees Celsius (C) conductors.

11. Interconnecting wiring diagrams shall include numbered terminal designations showing external interfaces. All terminations of wiring in all cabinets shall be labeled permanently to match the wiring diagrams.

12. Maximum total harmonic distortion generated by the UV System shall not exceed 5 percent the Institute of Electrical and Electronics Engineers (IEEE) 519-1992 Guidelines at the primary point of common coupling (PCC) for the System. The PCC is defined as the point of connection to the electrical switchgear powering the UV facility. Harmonic testing to be conducted during performance testing as defined in Article Installation of Equipment of this section.

13. Wiring in PDCs shall be properly spaced so that there is no deterioration of the wire insulation material or affect the wire rating.

2.7 INSTRUMENTATION AND CONTROLS

A. Scope of Work:

1. Provide tools, documentation, hardware, software, testing equipment, and personnel to support testing and training in accordance with sections in Division 40.

    a. System functional and component requirements specific to this installation will be developed with the selected Supplier. At that time, detailed submittal requirements, component specifications, panel construction, interface, control functions, and other instrumentation and control requirements will be defined.

    b. The Supplier shall furnish a complete Disinfection Control System. The Supplier shall furnish the System complete with PLC based monitoring and control system, operator interface panel, all input/output hardware, power supplies, programming, all interconnections to the UV-related instrumentation, controls, panels, and internal and external communication links.

    c. Provide Allen Bradley Compact Logix PLC (Outdoor 4X rated) with Allen Bradley Panelview 700 HMI touch screen. Provide all hardware, software, and licenses to support development, communications, runtime operations, and interface with Plant SCADA.

    d. Communication to field instrumentation, such as the channel low level sensors, the UV Intensity sensors, the UV transmittance analyzer, and the outlet level control gates shall be hardwired.

2. The UV control system shall provide complete and independent automatic control of the disinfection equipment and monitor process conditions, instrumentation, and equipment status. The UV control system shall provide alarms to indicate to operators that maintenance attention is required (i.e., minor alarms) and provide

alarms to indicate extreme condition in which the disinfection performance may be jeopardized (i.e., major alarms). The UV control system shall provide interlocks to prevent damage of equipment and provide for continuous unattended disinfection operation during normal conditions to meet the specified UV system performance.

3. The System shall automatically restart upon a power failure/power return.

4. SCC shall interface to Plant SCADA and PDCs using EtherNet/IP communications. Each PDC shall control and monitor one UV channel. The PDCs shall pass signals from the SCC to provide individual control of the UV banks.

5. The control functions of the System shall include the following:

    a. LOCAL and REMOTE control shall be provided for each influent channel gate and for each level control gate at the SCC. When the gate is in LOCAL, OPEN-STOP-CLOSE control shall be provided at the SCC. When the gate is in REMOTE, control shall be provided through the plant SCADA system if the gate is placed in MANUAL mode and through the SCC PLC when the gate is placed in AUTO.

    b. LOCAL and REMOTE control shall be provided for each UV channel at the SCC.

        1) In LOCAL, control of the UV banks is provided using the OIT at the SCC.

            a) In REMOTE, control can be provided through the plant SCADA system if the System is in Manual or through the SCC PLC if the System is in AUTO. In AUTO mode, an automatic flow paced UV disinfection control system shall be provided capable of responding to water quality and flow changes, maintaining a dose set-point at the SCC, and achieving the guaranteed microbial effluent discharge limit. The control system shall: Provide initial flow- paced logic for startup to open influent gates and to modulate lamp output or turn modules/banks ON and OFF so that the UV dose set-point is maintained.

            b) Use the total flow measured by the downstream Parshall flume divided by the number of channels in service for flow pacing.

            c) Include a dose pacing system to modulate the lamp UV output or turn lamps ON and OFF based on the calculated flow per channel and the UVT analyzer, when the banks are in the AUTO mode. The System shall be dose paced such that as the flow, lamp age, measured UV intensity, and water quality (transmittance) change the UV dose delivered is optimized above the dose set-point while conserving power.

            d) Include logic and time delays to regulate the UV bank ON/OFF cycle.

            e) Include logic to cycle UV banks for equal wear.

2) Changing operation modes, such as changing from AUTO to HAND at the PDC, shall be bumpless transfer. That is, banks that are ONLINE shall not be abruptly taken OFFLINE when mode transfer is occurring.

c. LOCAL and REMOTE operation of the automatic cleaning sequence shall be provided. When in LOCAL mode, control of the automatic cleaning system is provided using the OIT at the SCC. When in REMOTE, control shall be provided through the plant SCADA system if in MANUAL mode and through the SCC PLC if in AUTO.

6. Major alarm conditions shall include the following as a minimum:

a. Low Low UV Intensity Alarm (relative system intensity less than 25 percent).

b. Low Low UV Transmittance Alarm.

c. Multiple Lamp Failure Alarm: Shall indicate the failure of two or more lamps in any given lamp bank or if 10 percent of total lamps have failed. If this alarm is received and the system is in AUTO, another UV channel/bank, with a fewer number of failed lamps, shall automatically be turned ON or all UV channels/banks shall automatically be turned ON.

d. Module Failure Alarm: If this alarm is received and the system is in AUTO, another UV channel/bank shall automatically be turned ON.

e. Ballast Failure Alarm: If this alarm is received and the system is in AUTO, another UV channel/bank shall automatically be turned ON.

f. PLC Failure.

g. Communication System Failure.

h. Bank Failure to Energize.

i. Loss of Power to the SCC.

j. Loss of Channel Level Signals.

k. PDC/SCC High Temperature.

l. Influent Gate(s) Failure to Open-Close.

m. Effluent Gate(s) Position Failure, if applicable.

n. Cleaning System Failure.

o. Loss of flow signal upon failure of a bank to energize.

7. Minor alarm condition shall include the following as a minimum:

    a. Low UV Intensity Warning (relative system intensity less than 45 percent).
    b. Low UV Transmittance Warning.
    c. Individual Lamp Alarm Failure Alarm.

8. Operator Interface Terminal: Provide menu driven operator interface displays. The display shall include, as a minimum, the following:

    a. An overview graphic representing the UV lamp banks and associated power distribution centers. As a minimum, display bank status (ONLINE-OFFLINE, LOCAL-REMOTE, MANUAL-OFF-AUTO), UV intensity, UV transmittance, and UV influent flow.

    b. An alarm graphic showing the 20 most recent alarms, including time and date of occurrence. As a minimum, the alarms described above shall be provided. The alarms shall identify the affected equipment by location such as bank, module, lamp, etc.

    c. Displays for control and monitoring of all functions specified herein.

    d. Number of operating hours for each bank.

9. PDCs:

    a. The floor mounted PDCs and will be located adjacent to the UV system, outdoors. Enclosure shall be NEMA 4X 304 or 316 stainless steel.

    b. All internal components will be sealed from the environment. An internal heater will be provided to prevent condensation when the external temperature drops below the dew point.

    c. UL approved or equivalent.

    d. Power will enter the PDC from below and terminate in a load center.

    e. Each PDC shall be able to electrically isolate each bank of lamp drivers and safely replace a lamp driver without de-energizing any other operating banks

10. SCC:

    a. The SCC location will be adjacent to the UV system, outdoors. Enclosure shall be NEMA 4X 304 or 316 stainless steel. The SCC shall house the System PLC and the OIT.

b. System command, control, and status shall be accomplished through the OIT main screen display. In the event of a fault, the alarm will display on a pop-up Alarm window until the alarm has been manually or automatically cleared.

c. System operating information will be displayed on the OIT screen in both color graphic and text format. The information must be continuously updated. As a minimum the following information shall be displayed in the main screen simultaneously:

1) Number of channels/rows/banks/modules in service.
2) UV intensity.
3) Communication link status.
4) System flow pace mode (Hand-Auto).
5) UV lamp status.

d. Information, such as individual lamp hours and cycles, normally stored in the SCC shall be accessed using the touch screen display. Lamp cycles and hours shall be reset via a password protected screen.

e. Automatic and manual control of the lamp wiper system shall be controlled and monitored by the PLC. In the automatic mode, control of the wipers shall be based on time. The operator shall be able to alter the interval between cleaning cycles.

f. Individual channel inlet gates and effluent gates shall be controlled and monitored by the PLC.

11. Maintain proper operating temperatures inside all panels with ambient air temperature from 10 degrees Fahrenheit (F) to 115 degrees F.

B. PLC/Plant Control System Interface:

1. All communication with the Plant Control System shall be via EtherNet/IP communications.

2. As a minimum, the following information shall be monitored by the Plant Control System:

a. UV Disinfection Influent and Effluent Gate(s) status.
b. UV Disinfection Dosage.
c. UV Disinfection Transmittance.
d. UV Disinfection Intensity.
e. UV Disinfection Bank(s) Status.
f. UV Disinfection Bank(s) Operational Mode.
g. UV Disinfection Lamp(s) Status.
h. Major alarm conditions as identified in this section.

C. Field Instrumentation:

1. Communication to the SCC from field instrumentation shall be hardwired.

2. The following instrumentation and associated manufacturers shall be provided by the UV control system:

   a. Low Water Level Transmitters:

      1) Endress+Hauser Prosonic, or equal.

      2) One per channel.

      3) During all modes of operation, the level transmitters will ensure that lamps extinguish automatically if the water level in the channel drops below an acceptable level.

   b. UV Transmittance Analyzer:

      1) An on-line UVT monitor shall be provided to automatically and continuously track the UV transmission of the effluent at the 254 nm wavelength. UVT monitor will be UVAS as manufactured by Hach Company.

      2) The UVT monitor will measure transmittances from 25 to 100%.

      3) A shielded twisted pair cable to be provided by the Contractor for connecting the UVT monitor (4-20 mA signal) to the System Control Center. The SCC will modulate the lamp intensity in response to the effluent UV Transmission.

      4) Power feed of 100 – 230 VAC ± 10%, 50/60 Hz, 1 phase, 2 wire (plus ground), 50 VA required to the sensor located at the UV channel as shown on the Drawings.

   c. UV Intensity Sensor:

      1) Each UV module/bank shall have one ultraviolet intensity sensor.

      2) The UV intensity sensor shall be submersible.

      3) The UV intensity sensor shall not degrade after prolonged exposure to UV light.

      4) The UV intensity sensor shall continuously measure only the germicidal portion of the light generated (253.7 nm plus or minus 20 nm). The sensor must have a minimum sensitivity of 90 percent of the germicidal light.

5) The UV intensity shall be continuously displayed on the monitor, to a maximum of 99.9 milliwatts per square centimeter.

6) The UV intensity sensor shall be factory calibrated to a national testing standard.

7) Sensor should be contained in its own quartz sleeve and automatically cleaned at the same time as the other sleeves.

2.8 SPARE PARTS AND SAFETY EQUIPMENT

A. The Supplier shall furnish as part of the System the following spare parts and safety equipment:

1. Two UV lamps.

2. One quartz sleeves and holder seals.

3. One operators kit that includes UV-resistant face shield, gloves and cleaning solution.

2.9 DESIGN DRAWINGS

A. Supplier shall reference the attached design drawings for system layout and coordination:

1. P-611
2. M-612
3. M-613.

PART 3 EXECUTION

3.1 FACTORY TESTING AND INSPECTION

A. All major system components shall be factory tested for compliance with the construction and functional requirements specified in this section. Notification shall be provided to Engineer 30 days prior to the start of Factory Testing.

B. Factory Testing shall include the following:

1. Test all control panels to be furnished.

2. Test the entire PLC based control system by simulating inputs and verifying control logic steps. Upon completion, and prior to shipping equipment to the site, provide electronic copies of all PLC ladder logic and control programs fully documented and suitable for downloading into the PLCs.

a. The control system shall be paced through all routine alarm and failure modes to assure that the system has been completely debugged and is free from defects.

3. Verification through a quality control process that all equipment and System components were fabricated to specification, are free from defect, and are ready for shipment.

C. The Factory Test Report shall include, but is not limited to, the testing of the control panels and control logic.

D. Factory Test Report shall be submitted and approved prior to equipment being shipped to Site.

3.2 INSTALLATION OF EQUIPMENT

A. The Supplier shall provide the services of a trained representative to be onsite when the UV System equipment is delivered to sign off on UV System unloading and to ensure proper storage prior to installation.

B. Installation of equipment is to be done by Contractor, as required and instructed by the Supplier. Ancillary equipment required for installation (to include miscellaneous metals, anchor bolts, and hardware) shall be provided and installed by Contractor.

C. The Supplier shall perform all terminations of cables and conductors within electrical panels supplied as part of the System as well as final connections between PDCs and UV modules.

D. Contractor shall provide all conductors, cables, conduits, and/or cable trays, or raceways to power UVT and level instrumentation provided by the Supplier. Contractor shall provide a 20-amp circuit to the SCC and 120-volt power to the UV Interface Panel.

3.3 FIELD TESTING AND STARTUP

A. Field services shall conform to Section 01 75 00, Testing, Training, and Commissioning.

B. The Supplier shall provide the services of a trained representative to provide installation consultation, testing/startup services, and operation and maintenance training for the Owner’s personnel.

C. Following the Supplier’s calibration of instruments, the Supplier shall perform Component Testing and Performance Testing on the System. It will be the responsibility of the Supplier and Contractor to integrate testing and startup activities within the overall construction schedule.

D. Supplier shall provide a qualified representative of the manufacturer to be present during the startup. Supplier shall provide oversight of UV system, guidance of operational set-points, troubleshooting of issues that arise, and on-going hands-on training to Owner's operation and maintenance staff.

E. Component Testing: Prior to Performance Testing and Startup, the Supplier’s representative shall inspect the installed System for proper alignment, proper connection, and satisfactory function of all components. The Supplier’s representative shall approve the installation and provide a Certification of Proper Installation that the system components have been installed correctly and are ready for operation. Performance testing and Startup shall not commence until the certificate of proper installation and component testing report has been submitted and accepted.

1. Proposed component testing procedure shall be developed by the Supplier with input from Engineer. The Component Testing shall include:

   a. Automatic START/STOP and flow control of channels using the SCC.

   b. Automatic channel shutdown and startup in response to changes in flow rate and simulated water quality.

   c. Automatic channel changeover and shutdown in response to alarms.

   d. Automatic shutoff and alarm for various failure modes for each channel and for entire System.

   e. Operation of lamps with proper dose pacing in each channel for a period of 4 continuous hours. During this period, a minimal cooling water supply as specified by the Supplier will be circulated. Cleaning system operation frequency will initially be set during the component testing of each bank.

   f. Monitoring and recovery of operating data.

   g. Monitoring and control from the SCADA system.

   h. All control functions, both at local system and remote workstation.

   i. Operation of all monitoring instruments.

   j. The Supplier shall conduct component tests until each individual component item or system has achieved satisfactory operation and must demonstrate all operational features and controls during this period while in automatic modes.

2. Component testing shall include proving the interface between the SCC and the SCADA system. The Supplier’s representative shall coordinate with the plant

control system, and instrumentation and control (I&C) integrator during the interface test.

3. Component testing will be witnessed by Owner and shall demonstrate that the system and related control system operate in accordance with the specifications, including all operating, monitoring, and shutdown functions.

4. If, in the opinion of the Owner, the System meets the requirements specified herein, a Certificate of Proper Installation will be signed by the Supplier and Owner L and the System will be able to be Performance Tested. If, in the opinion of Owner, the component test results do not meet the requirements specified herein, the System will be classed as nonconforming.

5. In the case of a nonconforming system, advancement to performance testing will not commence until the Supplier has made, such adjustments, changes, and/or additions as are necessary to correct the System and demonstrated this by a satisfactory component test as specified above.

F. Performance Testing:

1. The performance testing shall be conducted to ensure that the guaranteed performance requirements as listed in Article Guaranteed Performance Requirements are satisfied.

2. The Supplier shall submit a proposed Performance Testing Plan before scheduling and conducting the test. The test shall not start until the Certificate of Proper Installation and an approved Performance Testing Plan are accepted by Owner.

3. During the performance testing, the Supplier shall start up and operate the System continuously for a minimum of 2 days. The performance testing shall be done to determine the actual system operating conditions and to verify that the System meets the guaranteed performance requirements of this Specification.

   a. The duration of the performance test is subject to continuation based on the system and/or system component failures as defined herein:

      1) Minor Alarms/Faults: Alarms and faults designated as minor shall not suspend or extend the performance testing unless continuous minor alarms impact the ability of the System to operate in full automation.

      2) Major Failure: A major failure in the System is one that decreases system capacity below 50 percent of maximum design capacity (i.e., an entire channel is rendered unavailable) for more than 24 hours. A major failure of the control systems is any event that requires operator intervention to restart or to re-establish normal system operation beyond that described

above. The performance test will restart from the beginning of the testing period, once the major failure has been corrected.

3) Wiper Faults/Failures: More than one wiper failure per bank shall result in suspension of the performance testing until the appropriate corrective action has been taken by the Supplier. The performance test will restart from the beginning of the testing period, once the problem has been corrected.

4) Disinfection Limit Grab Sample Failures: If the effluent E. Coli level in any microbial inactivation sample taken during the performance test is greater than 406 counts/100 millileters, the performance test will restart from the beginning of the testing period.

5) Disinfection Limit Average Failure: If the geometric mean E. Coli level of the microbial inactivation sampling at the end of the performance testing period is greater than 126 counts/100 millileters, the performance test will restart from the beginning of the testing period.

4. Control System: Verify that the PLC, SCC, SCADA System and network communications systems operate as intended. Verify that automatic transfer to redundant or backup banks, modules or channel is functional and that operator intervention to restart or to re-establish normal operation is required only during weekdays (between 7:00 a.m. and 3:30 p.m.). Any other manual intervention to restart or to re-establish normal operation of the control system is considered a major system failure.

5. Microbial Inactivation: The purpose of the microbial inactivation sampling is to confirm that the effluent quality meets the design requirements under actual operating conditions.

a. The test medium shall be unchlorinated secondary clarifier effluent within the range as defined in Table 1.

b. The Supplier shall collect and analyze samples to demonstrate compliance with the requirements of this Section. Sample frequency shall be twice per day, with no less than 2 hours between sample collections. During this performance test period, the Supplier shall provide all labor, sampling containers, and analytical services required.

1) The Supplier shall submit to Engineer as part of the Performance Test Plan lab certification and contact information of the analytical laboratory to be used for analyzing the samples collected during performance testing.

c. The Supplier shall perform the following schedule of tests:

Test	Sample Location	Frequency	Procedure
E. Coli	System Inlet and Outlet	2 times/day	Standard Methods (Method 9221)
UV Transmittance	System Inlet	2 times/day	Standard Methods (Method 5910)
Total Suspended Solids	System Inlet	1 time/day	Standard Methods (Method 2540D)

6. Head loss Test: Head loss through each channel shall be measured and plotted on a curve showing flow rate on the horizontal axis and head loss in inches of water on the vertical axis. The level at the exit of the inlet channel gate and upstream of the effluent control weir shall be used to determine the guaranteed performance requirements head losses.

7. A qualified representative of the Supplier shall supervise the performance testing, analyze data, and certify the System by furnishing a Certificate of Proper Performance. Tests shall be documented during continuous operation of the System, and the Supplier shall submit to Engineer three copies of a complete Performance Test Report containing all original test data, calculations, and a description of the performance testing procedures and results.

3.4 MANUFACTURER’S FIELD SERVICES

A. Qualified representative(s) for the equipment selected shall be present at the jobsite to complete the services herein:

1. One person-day for the installation assistance/supervision, inspection, certificate of shipment unloading, and completion of certificate of proper installation.

2. Three person-days for functional and performance testing and certification.

3. One person-day for classroom and/or jobsite training and startup assistance.

B. Training of Owner's personnel shall be at such times and at such locations as requested by the Owner.

END OF SECTION

SECTION 46 71 33 – ROTARY DRUM THICKENERS

PART 1 GENERAL

1.1 SUMMARY

A. This section covers the Work necessary to furnish, install, start up and test a complete rotary drum thickener(s) (RDT) equipment and any auxiliary equipment including flocculation tank, mixer, and all equipment, appurtenances, controls, and services as specified herein.

B. Rotary Drum Thickener (RDT) Manufacturer Responsibility:

1. Assemble, detail, and provide all of the equipment components specified herein.

2. Coordinate all facets of this project with Contractor to assure compliance with Contract Drawings and Specifications. All facets include structural, mechanical, piping, electrical, and instrumentation.

C. Unit Responsibility: All equipment supplied under this section shall be furnished by or through a single RDT Manufacturer who shall coordinate with the Contractor, the design, fabrication, delivery, installation, and testing of the RDT and components. The RDT Manufacturer shall have the sole responsibility for the coordination and performance of all components of the RDT system with the performance and design criteria specified herein.

1.2 RELATED SECTIONS

A. Section 05 50 00 – Metal Fabrication
B. Section 09 90 00 – Painting and Coating
C. Section 26 05 84 - Electric Motors
D. Section 26 29 23 - Low-Voltage Adjustable Frequency Drives (AFD)
E. Section 46 05 13 - General Requirements for Equipment

1.3 REFERENCE STANDARDS

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

1. American Bearing Manufacturer's Association (ABMA):

a. 9 - Load Ratings and Fatigue Life for Ball Bearings

b. 11 - Load Ratings and Fatigue Life for Roller Bearings

2. American Society for Testing and Materials (ASTM):

a. G 65 - Procedure A - Dry Sand/Rubber Wheel Test

b. A 36 - Specification for Structural Steel

c. A 48 - Specification for Gray Iron Castings

d. A 276 - Specification for Stainless Steel Bars and Shapes

e. A 320 - Standard Specification for Alloy-Steel and Stainless-Steel Bolting Materials for Low-Temperature Service

f. A 480 - Specification for Flat-Rolled Stainless and Heat Resisting Steel Plate, Sheet and Strip

g. A 500 - Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes

h. A 572 - Standard Specification for High-Strength Low-Alloy Columbium-Vanadium Structural Steel

i. A 992 - Standard Specification for Structural Steel Shapes

j. ASTM G 65 - Practice for Conducting Dry Sand/Rubber Wheel Abrasion Test.

3. American National Standards Institute (ANSI)

a. B 15 - Ball Bearings, Local Bearings and Fatigue Life

b. B 16.1 - ANSI Standard for Cast Iron Pipe Flanges and Flanged Fittings Class 25, 125, 250, and 800

1.4 DEFINITIONS

A. Polymer Dosage: Equivalent dosage of active polymer in pounds per dry ton of solids treated (lb/DT) applied.

B. Solids Capture:

1. Percent of feed solids that remain in thickened end product on a weight basis where:

$$\%\,Capture: \frac{T}{F} \times \frac{F-C}{T-C} \times 100$$

where:

T = Thickened Sludge TS (mg/kg)

F = Feed TS (mg/kg), excluding any dilution from polymer solution flow

C = Filtrate TS (mg/kg), excluding any dilution from polymer solution and wash water flows

1.5 SUBMITTALS

A. Product Data.

B. Performance Test Data.

C. Shop Drawings:

1. Make, model, and weight of each equipment assembly.
2. Complete catalog information, descriptive literature, specifications, and materials of construction.
3. Detailed structural and mechanical drawings showing the equipment dimensions, size, and installation.
4. Detailed structural and mechanical drawings showing motors, thickener drives, schematic wiring diagrams and interconnections wiring diagrams, interconnecting piping, pipe supports, control panel layouts, and size and length of each support frame member.
5. Polymer injection requirements and required valving or equipment.
6. If required for equipment maintenance, provide stair and platform access.
7. Factory protective coatings.
8. Manufacturer's standard Programmable Logical Controller (PLC) code used in the typical RDT control panel, in electronic format, for Contractor's reference.
9. Spare parts.
10. Wash down and spray water flow and pressure requirements.

D. Calculations: Include calculations of the following to support structural adequacy of RDT in conformance with seismic design criteria; performed, signed, and sealed by a registered professional structural engineer in the State of Oregon.

1. Structural anchor points to skid frame and concrete pad.
2. Seismic loads on skid frame and anchor bolts.
3. Roller bearing compliance bearing life at maximum loading.

E. Manufacturer's qualifications references, as required by Paragraph 1.6. Quality Assurance.

F. Technician qualifications resume: Submit resume of technician to perform RDT adjustments, inspections, observations of test operations, and training, as required by Paragraph 1.7. Quality Assurance.

G. Training course outline.

H. Quality Control Submittals:

1. Factory functional test report.

2. Field performance test report.

3. Certificate of Installation.

I. Maintenance Manual:

1. The following shall be included in the Maintenance Manual:

   a. Lubrication Instructions.
   b. Maintenance Instructions.
   c. Operation Instructions.
   d. Start-up Instructions.
   e. Unloading and Handling Methods.

2. Additional data as required.

J. Warranties.

K. Certificates.

1.6 QUALITY ASSURANCE

A. Manufacturer qualifications:

1. Regularly engaged in manufacture of RDTs in the United States for minimum 10 years that have been successfully used in domestic wastewater applications for thickening sludge in the United States.

2. Provide five references from operating installations for thickening of sludge at municipal wastewater treatment plants, with each unit operational for a minimum of 5 years. For each reference, provide model number, location, sludge stream and characteristics, number of units, starting date of operation, and contact information.

B. Technician qualifications: Employee of RDT manufacturer, factory trained, not sales representative, with minimum 5 years of experience performing rotary drum thickener adjustments, inspections, observations of test operations, and training.

1.7 SPARE PARTS

A. Furnish, tag, and box for shipment and storage the following spare parts and special tools:

1. One complete set of trunion wheels for each RDT.
2. One complete power bridge and printed circuit boards for each AFD.

1.8 WARRANTY

A. Manufacturer/Supplier shall guarantee that the equipment, materials, and performance shall be as specified herein and will be free of defects as a result of faulty design, materials, or workmanship for a period not less than 2 years from date of acceptance of equipment at the Job Site. Any conditions resulting in equipment failure or performance failure shall be considered a type of defect.

B. Any type of equipment failure or defect discovered during the warranty period or testing, regardless of its magnitude, shall be addressed and corrected to the satisfaction of the Owner by manufacturer, at no cost to the Owner. Owner shall not be responsible for any cost resulting from equipment failure during the warranty period.

1.9 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. RDT System Manufacturer/Supplier: Provide equipment FOB to Point of Destination as noted in the Contract Documents.

B. Installation Contractor: Responsible for receiving, unloading, and properly storing equipment in accordance with manufacturer/supplier's instructions. Equipment will not be accepted until after it is installed, tested, placed into operation, and found to comply with all specified requirements.

C. Manufacturer/Supplier: Responsible for inspection of all deliveries before unloading. Receiving report shall be prepared noting any and all evidence of damage in transit. Equipment that is damaged or does not meet requirements of approved Shop Drawings shall be returned immediately for replacement.

D. Label each skid, box, or package to show its net weight in addition to its content.

E. Protect finished iron or steel surfaces not required to be painted such as flange faces to prevent rust, corrosion, and damage.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Materials, equipment, and accessories specified in this section shall be products of:

1. FKC Co. LTD
2. Parkson Corporation
3. Alfa-Laval

2.2 BASIS OF DESIGN

A. Material Handled: See table below for feed stream characteristics.

Parameter	Value
Nominal Feed Composition, Total Dry Solids Weight Basis	Blended Raw PS/WAS (approximately 60% PS/40% WAS)
Sludge Feed Concentration, % Total Dry Solids Exclusive of Polymer	0.5 to 2%
Sludge Volatile Solids Concentration, % Volatile Solids Dry Weight Basis	0.1 to 2%

B. Sludge will be conditioned with a polymer as specified herein. Polymer dosage rate in pounds of active polymer per dry ton of solids is a required performance parameter that will be tested.

C. Provide equipment suitable for installation indoors, for exposure to continuous 100 percent relative humidity conditions, for operation in ambient air temperature from 40 degrees Fahrenheit (F) to 110 degrees F, and for exposure to biological sludge, splash, spill, and washdown conditions.

D. RDT System Components: A polymer injection ring, in-line mixer, flocculation tank, flocculation tank mixer, rotary drum with filtration media, support frame, spray deflection covering, spray wash header, booster pumps, if needed, and return water collection tank.

E. Provide skid-mounted system components, preassembled, and pre-piped to the maximum extent practical. Installation constraints may require units to be disassembled at Site and reassembled in place. Provide manufacturer's representative to inspect reassembled equipment where disassembly is required.

F. Design shown on Drawings is based on "A" named manufacturer above. Any changes to the arrangement indicated on Drawings must be approved by Engineer and Contractor shall be responsible for engineering costs for redesign by Engineer, if necessary.

2.3 PERFORMANCE REQUIREMENTS:

A. Continuously or intermittently receive, thicken the material, and discharge to a transfer pump up to 24 hours per day, 7 days per week.

B. Unthickened Material Feed Rate (applied to RDT): As shown in the following table.

Parameter	Minimum Condition	Average Condition	Maximum Condition
Feed Solids Loading Rate, lb/hr, Total Dry Solids (DS) Basis	50	100	250
Feed Hydraulic Loading Rates, gpm	10 @ 1% DS	20 @ 1% DS	60 @ 0.8% DS
Thickened Solids Concentration, % Total Dry Solids	4-6%	4-6%	4-6%
Minimum Total Solids Capture, %	95	95	95
Maximum Polymer Dose, lb Active per Dry Ton of Feed Solids	13	13	13

2.4 EQUIPMENT AND/OR MATERIALS

A. Fabricate all elements of the rotary drum thickener in contact with process liquids or solids from Type 304L stainless steel or Type 316 stainless steel, including floc development tank, input connection, discharge assembly, and driven impeller; rotary element composed of input assembly, single or multiple stages of rotary element, discharge assembly, filtration media covering various stages and all fasteners; shower deflection covering and all fasteners; washing header and fasteners. Supply principal elements of the rotary drum thickener fully assembled on an epoxy-coated carbon steel skid for simplified movement and installation.

B. Sludge Supply System:

1. RDT Manufacturer Responsibility: Coordinate with influent valves, flow meters, polymer feed injection and mixing systems, and other components that will provide automated sludge supply system to the rotary drum thickeners.

C. Flocculation Development System:

1. Connections:

    a. Minimum 6-inch flanged tangential inlet near top of tank.

    b. Tangential outlet(s) near bottom of tank. Size to be coordinated with manufacturer.

    c. Four-inch drain connection in bottom of tank.

    d. Where configuration of inlet flange and drain flange differ from what is shown on Drawings, call out changes as deviations for review by Engineer. Associated drain piping and control valve will be provided separately.

2. Driven Impeller of Flocculation Tank Mixer: A shaft and a necessary blade attached to shaft with a nylon steady bearing or other configuration approved by Engineer

3. All Metallic Components of Flocculation Tank Mixer: Type 304L stainless steel or Type 316 stainless steel.

4. Provide a discharge assembly to deliver conditioned sludge to receiving surface of rotary element.

5. Provide a flocculation tank cover to allow access to flocculation tank mixer with a hatch for observing interior of tank and 3-inch flanged ventilation line.

6. Provide a side tap for level element located as recommended by Manufacturer.

7. Tank:

    a. Type 304 stainless steel, minimum 10 gauge thick.

        1) Size for a minimum hydraulic detention time of 60 seconds at the unit's maximum rated hydraulic capacity.

2) Provide tank complete with mixer and mixer mounting bracket and hardware. Provide AFD-driven mixer gear motor. Mixer speed shall be adjusted in the RDT control panel.

3) Flocculation Tank Mixer Motor: Conform to requirements shown in attached Motor Data Sheet Rotary Drum Thickener Flocculation Mixer, at end of this section.

8. Static Mixer and Polymer Injection Ring (Provided by Manufacturer): Provide an inline static mixer, polymer injection ring, and manifolds for rotary drum thickener.

a. Static Mixer: Provide a 6-inch flange-by-flange, metal (iron or steel) in-line static mixer (non-clog variable orifice valve type), located as recommended by system supplier.

b. Polymer Injection Rings: Provide a four-port ultra-high-molecular-weight (UHMW) polyethylene body, flow splitting manifold with tubing and stainless-steel fittings between injection ring and manifold.

1) Polymer Injection Ring Ports: Provide a minimum of four ports to inject located 90 degrees apart around circumference of ring.

2) Injection Ring Inside Diameter: Not less than inside diameter of sludge feed piping.

3) Polymer Injection Ports: Provide 1/2-inch National Pipe Thread (NPT) threaded connections connected with 5/8-inch inside diameter (ID) transparent tubes to each of the four ports located on flow splitting manifold.

D. ROTARY SYSTEM

1. Single Stage or Multiple Stages Acceptable

2. Support Frame and Covers:

a. Frame: Type 304L stainless steel which supports rotary drum system in a minimum of three locations including both ends and middle.

b. Mount covers to frame which completely enclose rotating drum.

c. Seal covers to contain all water and mist.

d. Provide removable panels for access to screen for routine checks and maintenance.

3. Single-stage rotary system with single-step dewatering stage for solids to pass through before being discharged from end of unit.

    a. One-piece assembly or separate pieces bolted together.

    b. Constructed of Type 304L stainless steel or Type 316 stainless steel woven wire mesh, wedge wire, or Type 304L stainless steel perforated screen (20-gauge).

    c. Design single-stage drum to induce rolling of the sludge and minimize slippage.

    d. Internal Baffles (if included): Direct flow from inlet to point of discharge. Maximum drum speed shall be 10 revolutions per minute (rpm).

4. Drum:

    a. Maximum Drum Speed: 10 rpm.

    b. Construct Drum of Either:

        1) Wedge Wire: Provide V-shaped wires continuously welded together with a teardrop wire support structure to form inside of cylinder resulting in smooth cylindrical surface running the horizontal length.

        2) Woven Wire Mesh: Provide woven wire meshes covering each stage that can be easily changed with simple tools. Fasten woven mesh as outer covering of each stage and flange to outer surface of perforated metal housing surrounding each stage.

5. Multiple Stage Rotary System:

    a. Each stage, starting with input stage, shall function in distinct progression of intended dewatering program. Cover each stage with:

        1) Type 304 stainless steel woven wire mesh selected on the basis of porosity or percent openness, the opening size and the wire diameter used in the weaving process.]

        2) Perforated Type 304 stainless steel screen.

    b. Wire mesh or screen for each stage may vary from that supplied for other stages. Make wire or screen selections to maximize flow consistent with the requirements for high quality filtrate.

    c. Equip each stage with roll bars, split augers, ports, closures and/or deflectors to influence shear, water release and drainage rate independent of flow.

d. Deliver output solids by gravity from a series of detention rings separating the stages, progressively lower in the direction of discharge and directed by split augers.

E. WASHING SYSTEM

1. Provide a single or double self-cleaning washing header oriented in a horizontal position the length of rotary system to maintain positive cleaning with each revolution of rotary system, forcing washed off solids to return to mass of solids tumbling inside the rotary element.

2. Wash water pressure requirement shall be no more than 70 pounds per square inch (psi).

3. Total Wash Water Requirements: 40 gallons per minute (gpm) maximum per unit.

4. Return Water Collection: Contain and mount all elements of rotary system and supporting frame over return water or filtrate water collection tank. Deliver collected filtrate water by gravity through one 4-inch flanged pipe filtrate tank drain.

F. CONNECTION POINTS

1. Provide connection points for each rotary drum thickener for the following:

a. Flocculation Tank Inlet: 4-inch flanged.

b. Thickened Sludge Hopper Outlet: 6-inch flanged.

c. Filtrate Outlet: 4-inch flanged.

d. Spray Water Connections: 2-inch flanged.

G. CONTROL SYSTEMS

1. Controls for the entire RDT system will be incorporated directly into the Plant Control System without equipment main control panel. The Manufacturer shall be responsible for providing the required sizing information of the electrical components in the Manufacturer's scope of supply. All motors shall operate at 480-volt alternating current (VAC) unless specified otherwise.

H. DRIVE UNITS

a. The following drive units shall be supplied for each RDT:

1) Main Rotary Drum Thickener Drive:

a) 2.0 horsepower (minimum), 1,800 rpm, conforming to Section 26 05 84 with the exception of the following: a) Aluminum alloy frame is acceptable in lieu of cast-iron frame when cast iron frame is not available for selected motor.

b) The rotary drum thickener drive shall be controlled by an AFD.

2) Flocculation tank mixer:

a) 1.0 horsepower (minimum), 1,800 rpm and conforming to Section 26 05 84 with the exception of the following: a) Aluminum alloy frame is acceptable in lieu of cast-iron frame when cast iron frame is not available for selected motor.

b) The flocculation tank mixer drive shall be controlled by an AFD.

I. VARIABLE FREQUENCY DRIVE SYSTEMS

1. RDT Manufacturer: Coordinate all motor characteristics (including, but not limited to, voltage, rpm, and full-load current) with adjustable frequency drive manufacturer.

2. Size drives for a minimum of 1.15 x the nameplate FLA of the motors provided.

3. Provide drives in accordance with Section 26 29 23.

J. ANCHOR BOLTS

1. Type 316 stainless steel, sized by equipment manufacturer, 1/2-inch minimum diameter.

2.5 ACCESSORIES

2.6 FACTORY FINISHING

A. Prepare, prime, and finish coat in accordance with Section 09 90 00.

2.7 SOURCE QUALITY CONTROL

A. Factory Tests and Adjustments: Test all equipment for proper alignment, operation and intended function.

B. Function Test: Perform manufacturer’s standard motor test on equipment.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Install base level.

C. Adjust all assemblies so driving units are properly aligned, plumb, and level with driven units and interconnections.

D. Connect piping without imposing strain.

E. Anchor Bolts: Accurately place using equipment templates and as specified in Section 05 50 00, Metal Fabrication.

3.2 FIELD QUALITY CONTROL

A. Process Optimization:

1. A sludge evaluation shall be performed by the Manufacturer. Three weeks before optimization process the Owner will send to the Manufacturer a healthy, representative sludge sample. The Manufacturer shall perform optimization tests for the polymer. The Contractor shall notify the Owner two weeks prior to the shipping date.

2. Manufacturer to optimize process including, but not limited to, polymer dosage, unit drive speed, and floc drive speed.

3. Polymer selection shall be coordinated by Manufacturer with the Owner prior to optimization testing.

B. Functional Tests:

1. Functional testing of the entire rotary drum thickening system to be conducted following inspection, installation, and cleaning of the rotary drum thickeners.

2. Testing to be conducted by the Contractor and the Manufacturer representatives in the presence of the Engineer to demonstrate that equipment can perform its specified function in a satisfactory manner without mechanical or electrical defects, binding, or operational difficulties.

3.3 PERFORMANCE TESTING AND STARTUP

A. Conduct a performance test of the thickener system to verify that the unit meets the minimum performance requirements specified.

B. Performance test shall be 2 consecutive days in duration, 5 hours of operation for day one and 5 hours of operation for the second day.

C. Provide written test procedures including sampling frequency and analysis at least 30 days prior to start of testing.

1. Provide recommended polymer and polymer concentration.

2. Polymer selection shall be coordinated by Manufacturer with the Owner prior to performance testing.

D. Owner will provide polymer, wash water, power, sludge, sample bottles, lab testing, and thickened sludge pumping (if applicable).

E. Equipment and systems installed under this project may be utilized by the Manufacturer during the performance test.

F. The Manufacturer shall operate the equipment throughout the duration of the test, obtain the samples, and document the data needed to confirm the performance of the thickener unit.

G. Owner will provide or conduct the laboratory tests.

H. One sample of the following flow streams shall be obtained for each hour of operation during the performance test:

1. Feed sludge (%TS).

2. Filtrate (%TSS).

I. Thickened sludge (%TS).

J. The following process data shall be recorded and documented each hour of the test:

1. Feed sludge flow rate.

2. Polymer dosage and feed rate.

3. Cumulative thickened sludge flow (if available).

4. Alarm conditions.

5. Equipment problems.

6. Drum speed.

K. In the case of non-acceptable performance, the Manufacturer shall then have 15 days in which to perform at its sole expense, any supplemental testing, equipment adjustments, changes, or additions and request an additional retest of the non-acceptable system.

L. If the modified equipment then does not meet the guaranteed performance requirements of this Specification, all or part of the final payment for the rotary drum thickener shall be retained as damages.

3.4 MANUFACTURER’S SERVICES

A. Provide training after successful completion of performance test.

B. Manufacturer's Training: Train Owner personnel in proper operation and maintenance of the rotary drum thickening equipment. Allow minimum two training sessions of maximum 3 hours each following a course outline acceptable to the Engineer. Cover the following subjects:

a. Start-up procedures.
b. Shutdown procedures.
c. Troubleshooting.
d. Selection of proper polymer types and dosages.
e. Replacement of unit components.
f. Operating adjustments for performance optimization.
g. Preventive maintenance.
h. Maintenance procedures.
i. Emergency procedures.
j. Records keeping.

END OF SECTION

SECTION 46 73 11 – RADIAL BEAM FIXED DIGESTER COVERS

PART 1 GENERAL

1.1 SUMMARY

A. The fixed cover(s) shall be of the arched radial beam dome type with 1/4-inch minimum steel cover plates and shall conform to the Drawings and shall be designed for

1. The existing 55-foot diameter concrete digester tank.

2. The new 45-foot diameter concrete digester tank.

B. The cover(s) shall have a dome radius of 1.5 times the tank diameter and be held in position by thrust and compression rings.

C. Thrust ring, side skirt and lower rim angle splice joints: full penetration welds.

D. Cover plates shall be welded to the bottom (use "top" if Model F) of the erection beams. All internal joints and seams shall be continuously welded.

1.2 RELATED SECTIONS

A. Section 05 50 00 – Metal Fabrication

B. Section 09 90 00 – Painting and Coating

C. Section 46 05 13 - General Requirements for Equipment

1.3 REFERENCE STANDARDS

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

1. American Institute of Steel Construction (AISC) "Manual of Steel Construction"

2. American Welding Society (AWS) D1.1

3. ASTM International (ASTM) A36, A500, or A283.

4. Society for Protective Coatings (SSPC) standards and codes.

5. Uniform Building Code (UBC)

1.4 DEFINITIONS

1.5 SUBMITTALS

A. Shop drawings showing general equipment arrangement, welding details, dimensions, and materials.

B. Manufacturer's information, including catalog data, and other product literature showing equipment meets specified design criteria.

C. Submit design data, structural calculations, and shop drawings by a professional engineer. Drawings to include plan, sections, and connection details.

1.6 QUALITY ASSURANCE

A. Manufacturer shall be engaged in the design and fabrication of wastewater treatment equipment including digester covers used to enclose anaerobic sludge digester contents under pressure.

B. Manufacturer shall provide evidence that its personnel have expertise in digester cover design. The Manufacturer shall provide a list of at least 20 previous covers its personnel have designed, and its manufacturing facilities have produced demonstrating its ability to manufacture, design, and supply the specified covers.

C. To ensure quality and single point responsibility the manufacturer shall design and fabricate its equipment. The use of contract fabrication shops shall not be allowed.

D. At least one-quarter section of the digester cover shall be shop assembled to determine proper fit-up and compliance with specification and approval requirements prior to shipping.

E. All shop and field welding shall conform to the AWS D1.1 "American Welding Society" (AWS) codes using qualified AWS certified welders and procedures. Welds shall be 3/16-inch continuous fillets unless otherwise noted on the plans or the Manufacturer's shop drawings. Welding electrode shall be E70xx or equal wire. Field weld inspection shall be per AWS and with AWS Certified Welding Inspection (CWI) inspectors.

F. All shop and field coating shall be per The Society for Protective Coatings (SSPC) standards and codes.

1.7 SPARE PARTS

1.8 WARRANTY

A. Manufacturer shall warrant the equipment to be free from defects in material and workmanship for a period of 12 months from startup or 18 months from shipment, whichever is earlier.

PART 2 PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Olympus Technologies, Inc.

B. Ovivo

C. Or approved equal

2.2 BASIS OF DESIGN

A. All equipment and materials shall be designed and furnished by a single equipment manufacturer.

B. The structural design shall conform to the American Institute of Steel Construction (AISC) "Manual of Steel Construction", latest edition and local building codes.

C. The cover(s) shall be designed as a domed shell membrane. Radial members shall be provided for erection purposes and as required to stiffen the membrane.

D. All interior joints and seams shall be continuously welded. Exterior joints and seams shall be continuously welded where required by the manufacturer for structural purposes and/or gas tight construction and where top application of insulation is not performed.

E. To form a smooth uniform underside cover surface, gastight seal and for ease of protective coating applications, weld the beams to the top of the cover plates.

F. Alternative for Model F Covers: Weld beams to bottom of the cover plates.

G. The maximum stresses shall not exceed limiting stresses as set forth in the AISC specifications.

H. The cover(s) shall be designed with a side skirt, peripheral thrust ring and steel shell structure properly proportioned to match deflections and stresses.

I. All radial thrust loads shall be resolved by a peripheral thrust ring. As a minimum, the thrust ring and lower rim angle splice joint welds shall be complete joint penetration (CJP) full penetration.

2.3 PERFORMANCE REQUIREMENT

A. The design shall be adequate for the following minimum loadings:

1. Live and snow load: 40 pounds per square foot (psf) (uniform and uneven load from snow on one-fourth of the cover).

2. Wind load: 25 psf (on total projected area above the tank wall).

3. Internal design pressure: 16-inch of water column (wc).

4. Design vacuum pressure: 2-inch wc.

B. The design shall allow for the construction and fabrication loadings.

2.4 MATERIALS

A. The structural steel for arched radial beams shall conform to ASTM A36, A500, or A283, Grade C, with minimum thickness of 1/4-inch.

B. The steel cover plates, side skirts, manholes, gas dome, etc. materials shall be 1/4-inch minimum thickness.

C. FIXED COVER

1. ANCHORING

a. Anchor cover to the top of the digester tank wall.

b. Vertical loads shall be taken by the tank walls, not the cover side skirts.

c. Provide anchoring assembly at each of the radial beams to restrain upward movement of cover and minimize friction loads on digester wall from steel expansion / contraction.

d. Provide Teflon and 304 stainless steel bearing points as part of each anchoring assembly at all bearing points.

e. Design shall allow for lateral adjustment in field during erection.

f. The anchoring assemblies shall be as shown in the drawings.

D. SIDE SKIRT

1. Provide vertical side skirt located at a nominal distance of 2-inch from tank wall.

2. Extend side skirt a minimum of 6-inch below normal operating sludge level to trap gas.

3. Side skirt sections shall be designed with lifting lugs for use in field assembly located to provide lifting of the skirt sections in a level manner maintaining the skirt in the vertical plane.

4. Vertical skirt joints shall have shop welded back-up plates and temporary connection tabs used for convenience in field assembly.

5. Design horizontal shelf plate at bottom of side skirt to support annular sealant between side skirt and tank wall.

6. The Contractor shall provide and install annular sealants and packing as specified elsewhere in these specifications.

E. COVER PLATES

1. Cover plates shall be minimum 1/4-inch thick steel.

2. Cover plates shall be shop welded to each pair of arched radial beams to form a panel.

3. Closure plates shall be provided loose for field welding in between cover plate panels.

4. Each cover panel shall have temporary field assembly connection tabs to bolt panels to thrust ring sections and to center ring.

5. The cover shall be designed to be completely assembled with temporary tabs and bolts for ease in final field alignment and adjustments prior to field welding.

6. Tabs and bolts shall be removed after field welding.

F. PENETRATIONS

1. Provide normal appurtenances required as shown on the Plan drawings:

   a. Two 36-inch access manholes with gasket, flange bolts and cover.

   b. Two 6-inch schedule 40 sample tube with gasket, flange bolts and quick-open hatch cover.

   c. One center compression ring and cleanout port with gasket, flange bolts and cover.

d. One 4-inch flanged nozzle for pressure / vacuum relief valve with flame arrester.

e. One 6-inch flanged nozzle for gas take off-line.

2. The penetrations shall have flanges located a minimum of 6-inch above the finished levels of the cover.

2.5 ACCESSORIES

2.6 FACTORY FINISHING

A. All cover steel shall be shipped unpainted.

2.7 SOURCE QUALITY CONTROL

PART 3 EXECUTIONS

3.1 INSTALLATION

A. PIPE SUPPORTS

1. The Contractor shall provide mounting brackets and pipe support bases as required.

2. The brackets shall be designed for bolt up connection to pipe support base.

3. The cover manufacturer shall coordinate with Contractor.

4. No cover penetrations shall be allowed for pipe and / or handrail supports.

B. FASTENERS

1. All anchor bolts and structural fasteners shall be 5/8-inch minimum diameter.

2. Anchor bolt material: Type 304 stainless steel.

3. Flange bolt material: Type 304 stainless steel.

C. PAINTING

1. All steel surfaces to receive paint shall be prepared and painted per the latest edition of the SSPC Manual.

2. Steel preparation in the field and protective coating application shall be as specified in Section 09 90 00.

3. Testing of steel preparation and painting shall be per the SSPC Manual and the paint manufacturer's written instructions.

D. INSULATION (optional)

1. Insulation/weather proofing for the cover is as follows:

a. Apply coat of Gaco Western "adhesive" epoxy primer, E-5388 or equal.

b. Apply 3-inch of sprayed polyurethane foam insulation to achieve an R-21 insulation rating. Foam insulation shall be Gaco Western #251 or #303 and shall be applied in accordance with the manufacturer's instructions.

c. Apply 10 mils of Gaco Western SI-1000 silicone, light grey in accordance with Gaco instructions

d. Apply 10 mils a second coat of Gaco Western SI-1000 silicone, light grey.

e. Apply top-coat of 10 mils of Gaco Western SI-1000 silicone, light grey and immediately and uniformly broadcast quartz roofing granules at a 50 pounds per 100 square foot minimum application rate.

3.2 FIELD QUALITY CONTROL

A. Field Weld testing shall be in accordance with Section 6, AWS D.1.1, latest edition with the minimum level of non-destructive testing as follows:

1. Visual inspection of 100 percent of welds for size, undercut, etc.

2. Magnetic particle and/or dye penetrant as required for all joints suspected having cracks in the weld.

3. All CJP joints shall be inspected as required by Uniform Building Code (UBC) and AWS. Radiograph or ultrasonic tests shall be required per AWS.

B. Receive deliveries, handle, store, and protect equipment as recommended by manufacturer and as specified in other sections.

3.3 PERFORMANCE TESTING AND STARTUP

A. After assembly and field welding, test cover for gas tight construction by filling tank with water and trapping air beneath cover plate.

1. Pressurize air to 15-inch wc.

2. Check all welded seams for leaks by applying soap suds solution. Welds shall be cleaned with wire brush before testing.

3. Any leaks shall be carefully chipped out to sound metal, marked and then re-welded, re-tested, and re-painted.

4. Contractor shall be responsible for supply of the test water and testing equipment.

B. Other test methods may also be considered such as dye penetrant or vacuum box procedures. Prior approval shall be received from engineer before conducting such tests.

3.4 MANUFACTURER'S SERVICE

A. Provide a Manufacturer's service representative for inspection of completed installation. The Manufacturer's service representative shall also perform start-up and operator training. Service shall include at least one 8-hour day at the site.

END OF SECTION

SECTION 46 73 32 – INTERNAL DRAFT TUBE DIGESTER MIXING SYSTEM

PART 1 GENERAL

1.1 SUMMARY

A. This section includes furnishing an internal draft tube digester mixer to form a complete hydraulic mixing system to ensure successful operation and complete mixing of digester sludge.

B. The mixer shall be designed with vertical draft tube, drive assembly including reversible and ragless propeller, explosion proof motor, pressurized lubrication system, anchor bolts, and controls.

1.2 RELATED SECTIONS

A. Section 05 50 00 – Metal Fabrication

B. Section 09 90 00 – Painting and Coating

C. Section 26 29 23 - Low-Voltage Variable Frequency Drives (VFD)

D. Section 26 05 84 - Electric Motors

E. Section 46 05 13 - General Requirements for Equipment

1.3 REFERENCE STANDARDS

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

1. ASTM International (ASTM) A36
2. American Welding Society (AWS) D1.1
3. American Institute of Steel Construction (AISC) Manual of Steel Construction
4. Uniform Building Code (UBC)
5. National Electric Code (NEC), T2A

1.4 SUBMITTALS

A. Shop drawings showing general equipment arrangement, installation details, dimensions, and materials.

B. Descriptive information such as catalogs, performance data, and other product literature showing equipment meets specified design criteria.

C. Motor and speed reduction data.

D. Wiring diagrams and electrical schematics for control equipment.

1.5 QUALITY ASSURANCE

A. All equipment and materials shall be designed and furnished by a single equipment manufacturer.

B. The manufacturer shall be engaged primarily in design and fabrication of wastewater treatment equipment including digester mixers used to mix the contents of municipal anaerobic sludge stabilization digesters.

C. Manufacturer shall demonstrate its ability to design and fabricate the specified digester mixers.

D. To ensure quality and single point responsibility the manufacturer shall design and fabricate its equipment. The use of contract fabrication shops shall not be allowed.

E. The structural steel shall meet ASTM International (ASTM) A36. Steel pipe shall meet ASTM A53. All steel components intermittently or continuously in contact with liquid shall have a minimum thickness of 1/4-inch.

F. Fabrication and welding of structural steel components shall conform to the latest revisions of American Welding Society (AWS) D1.1.

G. Fabricated steel design shall conform to American Institute of Steel Construction (AISC) Manual of Steel Construction, and Uniform Building Code (UBC).

1.6 SPARE PARTS

A. Provide one set of drive belts.
B. Provide one mixer mounting flange gasket.

1.7 WARRANTY

A. Manufacturer shall warrant the equipment to be free from defects in material and workmanship for a period of 12 months from startup or 18 months from shipment, whichever is earlier.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Receive deliveries, handle, store, and protect equipment as recommended by manufacturer and as specified in other sections.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Olympus Technologies, Inc.

B. Ovivo

C. Or approved equal

2.2 BASIS OF DESIGN

A. Mixing equipment shall be a simple, robust, and highly-effective hydraulic mixing system utilizing a vertical draft tube, reversible and ragless propeller, and radial flow deflector to impart mixing energy sufficient to completely mix the contents of each digester.

Tank Details:

Tank Size (L/W, Ø):	55 feet	Tank Bottom Shape (Conical/Slopped/Flat/etc.)	Flat
Tank Height:	15 feet	Tank Volume	230,000 gal
Liquid Level (max/min):	13/12.5 feet	Solids Concentration (%):	2.5%

B. The mixing system shall be designed to create a flow pattern that ensures uniform solids suspension throughout the tank using a vertical draft tube, reversible and ragless propeller, and radial flow deflector. The equipment design and configuration shall be selected and positioned such that the contents are recirculated in an axial flow manner to ensure complete mixing.

C. The mixing system shall be configured such that a flow pattern is established to promote a strong vertical flow, ensuring uniform mixing throughout the tank. A strong vertical flow is critical in creating a roiling liquid surface to incorporate scum and other floating material. The complete mixing system, consisting of draft tube, propeller, radial deflector, and all appurtenances, shall be sized and supplied by the manufacturer. The manufacturer will recommend the specific configuration required to meet process requirements. The manufacturer must have in-house Computational Fluid Dynamics (CFD) capability to accurately model the full-scale operational system and compare CFD results with the recommendations to ensure process requirements are met.

2.3 PERFORMANCE REQUIREMENT

1. The mixing system supplier must have in house CFD capability and must provide models to validate design. The models are to show specific tank geometry, solids content, and equipment configuration at the submittal stage.

2. Mixing system supplier shall perform a CFD analysis for each unique mixing system. One CFD analysis maybe performed for mixing systems for tanks with identical sludge characteristics and geometries.

3. CFD analysis shall be performed using fluid rheology.

    a. Wastewater Sludge Rheology to be modeled using the Ostwald de Waele method, unless otherwise specified:

    $\boldsymbol{\tau = K * \gamma^n}$
    τ = Shear Stress (Pa)
    γ = Shear Rate (s^{-1})
    K = Fluid Consistency Co-efficient ($Pa*s^{-1}$)
    n = Fluid Behavior Index

B. The following shall be submitted with the CFD Report:

1. Contours allowing visualization of developed velocities with a domain plane.

2. Particle streamlines displaying the path 10 or more particles would take as they move through fluid domain.

3. ISO-Surfaces displaying the physical shape of velocity distributions within the domain.

4. Tabulated Velocity Distributions within the domain.

C. The CFD report shall confirm the following performance conditions:

1. Mixed Volume Condition: Fluid Velocity must be above 0.2 feet per second in greater than 90 percent of the active volume.

2. Mixing Time Condition: Mixed Volume Condition must be achieved within 60 minutes of operation

3. Dead Spot Condition: 95 percent of the active volume shall have a fluid velocity of greater than 0.05 feet per second.

D. Field Performance:

1. The mixing system total solids concentration of any one sample taken shall be within 10 percent of the average total solids concentration of all samples taken from the tank.

2.4 COMPONENTS

A. MIXER DRAFT TUBE

1. The vertical draft tube shall be comprised of an upper section supported by the digester cover.

   a. It shall be designed with a safety cylinder designed to allow removal of the mixer mechanism without the loss of gas pressure or without variation of the liquid from normal operating conditions.

   b. The upper draft tube shall be designed to be removable with a structural steel mixer mounting flange, gasket, and flange bolts.

   c. The upper draft tube shall extend sufficient length to enclose the mixer propeller and extend into a lower draft tube extension.

   d. The upper draft tube mounting flange shall be designed with a structural mounting fixture to secure the drive motor and provide adjustment for belt tension.

2. A lower draft tube extension shall be provided with anchorage as shown on the plans. The extension shall overlap the upper draft tube section by at least 1-foot at all operating conditions.

   a. The draft tube extension shall be designed with a vertical intake/discharge port at the lower end.

   b. The extension supports and anchorage shall be as shown on the plans.

B. ROTATING ASSEMBLY

1. The drive shaft shall be a 3-inch minimum diameter steel.

   a. It shall be enclosed within a 6-inch schedule 80 pipe shaft housing.

   b. The upper end of the shaft shall have an anti-friction grease lubricated spherical roller bearing.

   c. The upper shaft bearing shall be designed to withstand axial and radial dynamic mixer loads. It shall be replaceable without removing the mixer from the vertical draft tube.

d. The lower shaft bearing shall be located near the end of the shaft housing. The bearing shall be an anti-friction double-race taper roller bearing.

e. To ensure optimum service life of the seals, self-aligning type bearings such as spherical roller or self-aligning ball bearings shall not be allowed for the lower bearing.

2. Both upper and lower bearings and the shaft shall be protected from contact with foreign materials and the digester contents with the following seals.

   a. The upper bearings shall be protected from the entrance of foreign materials by Type "R" dual lip seals.

   b. The lower bearing shall be protected above and below with mechanical seals and from below also by a labyrinth seal. The labyrinth seal shall be designed to minimize sludge intrusion into the bearing and seal area. Designs not using a labyrinth seal will not be accepted.

   c. The lower bearing, the mechanical seals and the labyrinth seal shall be designed to be installed and replaceable as a single cartridge unit. Designs requiring separate field handling of bearings, mechanical seals and the labyrinth during replacement will not be accepted.

   d. The bearings shall have L10 service life of 30 years or more.

3. A flow deflector shall be provided to assist in the directional transition from vertical to horizontal flow. To prevent lateral movement of the mixer housing and shaft, a positive stabilization device shall be provided as an integral part of the flow deflector. The device shall stabilize the mixer in the draft tube with contact points to provide uniform pressure between the device and the draft tube.

4. To prevent accumulation of stringy and fibrous materials and to facilitate flow characteristics, the diameters of the propeller hub and shaft housing shall be the same or have a tapered and smooth transition from one to the other.

5. The rotating assembly shall include lubrication for both the upper and the lower bearings.

   a. To prevent intrusion of sludge across the mechanical seal faces in the lower bearing area, a pressurized oil lubrication system is to be provided to maintain the lower bearing area at a positive pressure.

   b. The upper bearing shall be periodically lubricated manually through grease application hoses and fittings.

6. The mixer shall include a three-bladed cast iron reversible and ragless propeller. The propeller shall be designed to circulate liquid at a rate of _____ gallons per minute (gpm) in either the upper or downward pumping direction.

7. The shaft shall be turned by a belt drive system using V-belts and appropriate sheaves and bushings.

8. The mixer drive mechanism shall be provided with a stainless steel drive belt guard designed to Occupational Safety and Health Administration (OSHA) requirements and including quick-release guard locks.

9. A drive belt tensioning device shall be provided for proper tensioning of the drive belts. This device shall be protected by a steel enclosure and shall use a zinc-plated ACME threaded adjustment screw with stainless steel yoke and carrier. Operation of the device shall be smooth and easy. Tensioning devices using standard National Pipe Thread (NPT) threaded rods and nuts and those which are not enclosed shall not be accepted.

10. The mixer drive assembly shall be designed to allow removal from the vertical draft tube without removing the drive motor or disconnecting any electrical wiring. In addition, release of the stabilization device during mixer removal shall be automatic.

C. DRIVE ASSEMBLY

1. The mixer drive assembly housing flange shall be fabricated of 3/4-inch steel plate. It shall be provided with gaskets as required to provide gas-tight connection to the draft tube. A separate 3/4-inch mixer base plate shall be provided for mounting of the drive motor, belt tensioning device, automatic lubrication system and belt guard.

2. Provide totally-enclosed, fan-cooled (TEFC) reversible drive motors.

3. Provide ______7.5 horsepower explosion proof motor.

4. Nominal motor speed, 1,800 revolutions per minute (rpm).

5. Service factor, 1.15.

6. National Electric Code (NEC), T2A.

7. Voltage, 230/460.

8. 60-hertz, 3-phase

D. CONTROLS

1. For each mixer provide an explosion proof local control station. The local station shall include a switch for on / off operation.

2. Provide one remote control panel, per the plans, to be wall mounted in the control room.

3. Controls shall have lock-out capability so mixer cannot be operated during repair or service periods.

E. FASTENERS

1. All anchor bolts and structural fasteners shall be 3/4-inch minimum diameter.

2. Anchor bolt material: Type 304 stainless steel.

3. Flange bolt material: Type 304 stainless steel.

2.5 ACCESSORIES

2.6 FACTORY FINISHING

A. Mixer draft tube, rotating and drive assemblies including mixer mounting flange shall receive a shop finish coat of 3M Scotch Kote, DuPont Nap-Guard or equal fusion bonded epoxy, 8-10 mils dry film thickness (dft). Top-coat all surfaces exposed to the weather with weather resistant powder coating of Tiger Drylac or equal, 2-4 mils dft.

B. All mixer vendor supplied items shall have the manufacturers standard shop paint provided.

C. Prepare, prime, and finish coat in accordance with Section 09 90 00.

2.7 SOURCE QUALITY CONTROL

A. Factory Tests and Adjustments: Test all equipment for proper alignment, operation and intended function.

B. Function Test: Perform manufacturer's standard motor test on equipment.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Install base level.

C. Adjust all assemblies so driving units are properly aligned, plumb, and level with driven units and interconnections.

D. Install and adjust all flow control surfaces and components in accordance with manufacturer's specifications.

E. Install components without imposing strain.

F. Anchor Bolts: Accurately place using equipment templates and as specified in Section 05 50 00, Metal Fabrication.

3.2 FIELD QUALITY CONTROL

A. Functional testing of the entire mixing system to be conducted following inspection and installation.

B. Testing to be conducted by the Contractor and the Manufacturer representatives in the presence of the Engineer to demonstrate that equipment can perform its specified function in a satisfactory manner without mechanical or electrical defects, binding, or operational difficulties.

C. Test each mixer as follows.

1. With the tank full of water, operate each mixer for at least 1-hour in both directions.
2. Check all flange bolts for tightness.
3. At each test condition, check mixer shaft RPM and direction of rotation.
4. Check motor amperage.
5. Check all other assemblies as outlined in the Installation, Operation, and Maintenance manual.

3.3 MANUFACTURER'S SERVICES

A. Provide a manufacturer's service representative for installation assistance, inspection training. The manufacturer's service representative shall provide the following minimum service:

1. One site visit of at least one 8-hour day to assist in installation and/or certification of proper mixer drive installation into the draft tube.
2. One site visit of at least one 8-hour day to provide final inspection of equipment installation and operator training.

END OF SECTION

SECTION 46 73 40 – DIGESTER SLUDGE MIXING SYSTEM

PART 1 GENERAL

1.1 SUMMARY

A. This section includes furnishing nozzle mixing assemblies and mixing pumps to form a complete hydraulic mixing system to ensure successful operation and complete mixing of digester sludge.

B. The project Contractor, unless otherwise specified, shall supply pump suction piping, discharge piping between pump and the mixing nozzle assemblies, piping supports, controls, valves, variable frequency drive, gauges, and other specialties required to form a complete hydraulic mixing system.

1.2 RELATED SECTIONS

A. Section 05 50 00 – Metal Fabrication

B. Section 09 90 00 – Painting and Coating

C. Section 26 29 23 - Low-Voltage Variable Frequency Drives (VFD)

D. Section 26 05 84 - Electric Motors

E. Section 46 05 13 - General Requirements for Equipment

1.3 REFERENCE STANDARDS

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

1. Hydraulic Institute Standard 14.6
2. ASTM A48 Cast Iron
3. ANSI B16.1

1.4 DEFINITIONS

1.5 SUBMITTALS

A. Shop Drawings:

1. Make, model, and weight of each equipment assembly.
2. Identification of materials of construction.

3. Detailed structural and mechanical drawings showing the equipment dimensions, size and locations of connections, and weights of associated equipment.

4. Process data including flow rates, temperatures, pressure drops, and surface area.

5. Factory finish system.

B. Quality Control Submittals:

1. Operation and maintenance (O&M) manual.
2. Special shipping, storage and protection, and handling instructions.
3. Manufacturer’s printed installation instructions.

1.6 QUALITY ASSURANCE:

A. The nozzle assemblies and pumps, along with all required supporting layout documentation, shall be furnished and guaranteed by one supplier.

B. The manufacturer shall be engaged primarily in design and fabrication of wastewater treatment equipment including digester mixers used to mix the contents of municipal anaerobic sludge stabilization digesters.

C. Manufacturer shall demonstrate its ability to design and fabricate the specified digester mixers.

D. To ensure quality and single point responsibility the manufacturer shall design and fabricate its equipment. The use of contract fabrication shops shall not be allowed.

1.7 SPARE PARTS

1.8 WARRANTY

A. Manufacturer shall warrant the equipment to be free from defects in material and workmanship for a period of 12 months from startup or 18 months from shipment, whichever is earlier.

B. Extended Nozzle Warranty: In addition to the above, manufacturer shall warrant nozzles for a period of 10 years from the earlier of either the 18 months from shipment or 12 months from startup. Warranty shall be non-prorated, and the manufacturer shall be responsible for the replacement with new nozzle assemblies for any nozzle worn to the point of affecting mixing performance of the system.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Rotamix manufactured by Vaughan Co., Inc.

B. HydroMix manufactured by Hayward Gordon ULC.

C. The drawings and specifications were prepared based on the Rotamix System by Vaughan Co., Inc. Contractor shall include in the Bid and shall be responsible for the cost of any changes, including engineering changes, to accommodate equipment the other than Base Bid equipment including but not limited to structural, mechanical, and electrical work.

2.2 BASIS OF DESIGN

A. Mixing equipment shall be a simple, robust, and highly-effective hydraulic mixing system utilizing pump(s) and nozzles to impart mixing energy sufficient to completely mix the contents of each digester.

Tank Details:

Tank Size (Ø):	40 feet	Tank Bottom Shape (Conical/Slopped/Flat/etc.)	Conical
Tank Height:	24 feet	Tank Volume	270,000 gal
Liquid Level (max/min):	22 feet	Solids Concentration (%):	2.5

B. The mixing system shall be designed to create a flow pattern that ensures uniform solids suspension throughout the tank using one or more pumps in conjunction with strategically placed nozzles. The number of nozzles and their orientation shall be selected and positioned such that the contents are recirculated in a top to bottom manner in addition to a circular flow pattern to ensure complete mixing.

C. The nozzles shall be configured with both horizontally and vertically angled outlets, such that a flow pattern is established parallel to the tank bottom and vertically angled to promote a strong top to bottom movement, ensuring uniform mixing throughout the tank. This strong vertical flow is also critical in creating a roiling liquid surface to incorporate scum and other floating material. The complete mixing system, consisting of chopper pump(s) and nozzle assemblies, will be sized and supplied by the manufacturer. The manufacturer will recommend the number, size, location, orientation, and flow rate of nozzles required to meet process requirements. The manufacturer must have in-house Computational Fluid Dynamics (CFD) capability to accurately model the full-scale operational system and compare CFD results with the recommendations to ensure process requirements are met.

2.3 PERFORMANCE REQUIREMENT

A. CFD Analysis:

1. The mixing system supplier must have in house CFD capability and must provide models to validate design. The models are to show specific tank geometry, solids content, and nozzle placements at the submittal stage.

2. Mixing system supplier shall perform a CFD analysis for each unique mixing system. One CFD analysis maybe performed for mixing systems for tanks with identical sludge characteristics and geometries.

3. CFD analysis shall be performed using fluid rheology.

   a. Wastewater Sludge Rheology to be modeled using the Ostwald de Waele method, unless otherwise specified:

      $\boldsymbol{\tau = K * \gamma^{n}}$
      $\boldsymbol{\tau}$ = Shear Stress (Pa)
      $\boldsymbol{\gamma}$ = Shear Rate (s^{-1})
      K = Fluid Consistency Co-efficient ($Pa*s^{-1}$)
      n = Fluid Behavior Index

B. The following shall be submitted with the CFD Report:

1. Contours allowing visualization of developed velocities with a domain plane.

2. Particle streamlines displaying the path 10 or more particles would take as they move through fluid domain.

3. ISO-Surfaces displaying the physical shape of velocity distributions within the domain.

4. Tabulated Velocity Distributions within the domain.

C. The CFD report shall confirm the following performance conditions:

1. Mixed Volume Condition: Fluid Velocity must be above 0.2 feet per second in greater than 90 percent of the active volume.

2. Mixing Time Condition: Mixed Volume Condition must be achieved within 60 minutes of operation

3. Dead Spot Condition: 95 percent of the active volume shall have a fluid velocity of greater than 0.05 feet per second.

D. Field Performance:

1. The mixing system total solids concentration of any one sample taken shall be within 10 percent of the average total solids concentration of all samples taken from the tank.

2.4 COMPONENTS

A. Nozzle Assemblies

1. Nozzles shall be nitrided 316 Stainless Steel with a hardness of 650 Brinell Hardness Number (BHN) or Glass Lined Ductile Iron. Nozzles assemblies shall have a minimum wall thickness of 1-inch.

2. Nozzles shall be adjustable in 360 degrees through the use of adjustable flanges or grooved couplings.

3. Assembly fittings shall be constructed from nitrided 316 Stainless Steel with a hardness of 650 BHN or Glass Lined Ductile Iron.

4. Connection of the feed piping to the nozzle assembly shall be a flange-to-flange-type. Single Nozzle assemblies will have a Ø6-inch-150# flanged connection. Dual Nozzle assemblies shall have a Ø8-inch-150# flange connection. Flange gaskets shall be Buna-N.

5. Sizing of nozzles shall be the responsibility of the equipment manufacturer. Equipment manufacturer shall be responsible for determining accurate system head losses based on actual nozzle size and piping layout. Any changes required to enhance system performance, including changes to the Mixing Pumps, pump piping, and electrical requirements, shall be the responsibility of the equipment manufacturer.

B. Solids Handling Pump

1. General:

a. All mixing pumps shall be chopper type designed to shred any material small enough to pass through the mixing nozzles without clogging the nozzles.

2. Pump Construction:

a. The pump casing will be constructed of ASTM A48 Cast Iron. Flanged suction and discharge connections shall conform to the requirements of ANSI B16.1, Class 125. Casings with 4-inch or larger discharge diameter shall have an inspection port with removable cover to allow access to the casing passage. An inspection port shall also be provided in the suction spool piece to allow access to the front of the impeller and cutter bars. The casing backplate shall have spiral cutting groove on the surface that is in close clearance to the rear of the impeller. The casing shall be a clamp type design, with integrally cast feet to allow removal of the power frame for maintenance without disturbing the suction or discharge piping.

b. The pump impeller shall be an open type with sharpened vane edges incorporated into the rear of the impeller which provides cutting action against the backplate spiral groove, preventing fouling behind the impeller. Primary chopping/conditioning of materials shall be accomplished by the action of the sharpened leading edges of the impeller blades moving across the cutter bar at the intake openings with a set clearance between the impeller and cutter bar of .010-inch to .015-inch on pumps with less than 14-inch diameter impellers or .020-inch to .030-inch on pumps with 14-inch diameter or larger impellers. Impeller shall be constructed of cast alloy steel, case hardened to minimum Rockwell C 60 and shall be dynamically balanced. The impeller shall be keyed to the shaft and the axial clearance at the front and rear of the impeller shall be externally adjustable.

c. The casing will be fitted with a replaceable, externally adjustable suction plate with integral cutter bars constructed of cast alloy steel case hardened to minimum Rockwell C 60. The surface of the suction plate facing the impeller shall have multiple radial cutting slots to prevent binding of material between it and the impeller vanes. Pumps with 15-inch or larger impeller diameters shall have separately replaceable cutter bars independent of the main suction cover.

d. The impeller shall be secured to the shaft using a deflector nut made from 410 Stainless Steel hardened to 400 BHN, designed protrude in front of the cutter bars and deflect stringy materials and prevent binding.

e. The area behind the impeller shall be protected from fouling by the cutting and expulsion action of sharpened vane edges sweeping across spiral grooves in the casing backplate.

f. The shaft will be constructed of 4140 carbon steel, protected through the seal area by a renewable 316 Stainless Steel sleeve. An O-ring between sleeve and shaft will prevent pumped fluid from leaking along the shaft.

g. Radial bearings on all sizes of pump shall be cylindrical roller type to withstand high radial loads during chopping. Axial thrust in both directions shall be taken up by double row angular contact thrust bearings on pumps with less than 14-inch diameter impellers or by higher capacity double row tapered roller bearings for pumps with 14-inch diameter or larger impellers. The bearing lives are to be rated for a minimum of 100,000 hours. L10 life, based on calculated loads due to hydraulic thrust encountered at the duty point, as well as other mechanical loading due to belt drives or shaft and impeller weight.

h. The bearing frame shall be A48 Class 30 cast iron and should be fitted with grease nipples for grease lubrication or with an oil level sight gauge, vent, and drain plugs for oil lubrication. The axial thrust bearing shall be contained in a separate housing mounted within the power frame to allow for external axial adjustment of the impeller clearance. The bearing frame shall be removable for servicing without disturbance of the suction or discharge piping.

i. The seal housing shall be constructed of ASTM A48 CL30 Cast Iron.

j. Seal Types:

   1) Single mechanical seal with throttling bushing or double mechanical seal. Either configuration to be fitted for clean water flush.

   2) Flushless mechanical seal system designed to require no clean water flushing. System to consist of the stuffing box portion of the seal housing having a tapered opening of no less than 20 degrees to promote the expulsion of solids back into the pumped flow. The seal shall be front loading and of the cartridge type with Viton O-rings, silicon carbide faces and 316SS metal parts. The cartridge seal shall be pre-assembled and pre-tested so that no seal settings or adjustments are required. Any springs used to push the faces of the seals together must be shielded from the pumped fluid to prevent binding or hang-up of the seal. A separate oil chamber shall not be required for the mechanical seal.

   3) Any leakage will be retained by a drainable reservoir, with a 0.75-inch National Pipe Thread (NPT) hole provided to connect drainage piping.

k. Pump and Motor Base:

   1) Horizontal: The pump and motor base shall be fabricated from steel, designed to provide rigid support of the pump and foot mounted motor. Each base shall be furnished with suitable bolt and grout holes to facilitate mounting at site. Units shall be provided with either V-Belts and sheaves or a direct drive coupling to provide the required pump speed to meet performance conditions. Suitable Occupational Safety and Health Administration (OSHA) guards are required.

   2) Vertical Dry Pit Mounting: The pump shall be supported by an independent pedestal base fabricated from steel or Cast Iron, designed to provide rigid

support of the pump and motor. The independent pump support pedestal shall be designed for easy access to the hand hole cleanout and such that the suction elbow can be removed for maintenance without having to remove or dismantle any of the pump components.

C. Motors

Horsepower (HP)	25
Speed (RPM)	1170
Electrical (V/Ph/Hz)	460/3/60
Enclosure	TEFC
Insulation	
Inverter Duty	Y
Service Factor	1.15

2.5 ACCESSORIES

2.6 FACTORY FINISHING

A. Prepare, prime, and finish coat in accordance with Section 09 90 00.

2.7 SOURCE QUALITY CONTROL

A. Factory Tests and Adjustments: Test all equipment for proper alignment, operation and intended function.

B. Function Test: Perform manufacturer’s standard motor test on equipment.

C. Factory Pump Performance Test:

1. Setup and test all mixing pumps at the factory in accordance with Hydraulic Institute Standard 14.6, to grade 1U. The test shall confirm the rated operating point for the mixing pumps as well as develop an operating curve at the specified pump speeds or impeller trim. Performance Curves shall be developed by using no less than six tested operating points. Certified test curves showing the performance characteristics of the mixing pumps shall be submitted to the engineer for approval prior to the pump being shipped to site.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install in accordance with manufacturer’s instructions.

B. Install base level.

C. Adjust all assemblies so driving units are properly aligned, plumb, and level with driven units and interconnections.

D. Install and adjust all nozzles in accordance with manufacturer's specifications.

E. Install components and connect piping without imposing strain.

F. Anchor Bolts: Accurately place using equipment templates and as specified in Section 05 50 00, Metal Fabrication.

3.2 FIELD QUALITY CONTROL

A. Functional testing of the entire mixing system to be conducted following inspection and installation.

B. Testing to be conducted by the Contractor and the Manufacturer representatives in the presence of the Engineer to demonstrate that equipment can perform its specified function in a satisfactory manner without mechanical or electrical defects, binding, or operational difficulties.

3.3 PERFORMANCE TESTING AND STARTUP

A. Provide the services of a qualified manufacturer representative to inspect the installation of the mixing system to ensure the mixing pump performance requirements shall be met.

B. Each mixing pump shall be subjected to a mechanical test on site by a qualified manufacturer representative in accordance with manufacturer recommended startup procedures and checklist.

3.4 MANUFACTURER'S SERVICES

A. Provide a manufacturer's service representative for installation assistance, inspection training. The manufacturer's service representative shall provide the following minimum service:

1. One site visit of at least one 8-hour day to provide final inspection of equipment installation, operator training, and startup.

END OF SECTION

SECTION 46 76 27 – DEWATERING SCREW PRESS

PART 1 GENERAL

1.1 SUMMARY

A. This section includes a dewatering system including in-line flocculation tank and dewatering screw press with drivers. All equipment shall be provided by a single manufacturer. The dewatering system line shall be capable of dewatering municipal anaerobically digested sludge.

B. Unit Responsibility: All equipment supplied under this section shall be furnished by or through a single screw press Manufacturer who shall coordinate with the Contractor, the design, fabrication, delivery, installation, and testing of the dewatering screw press and components. The screw press Manufacturer shall have the sole responsibility for the coordination and performance of all components of the screw press system with the performance and design criteria specified herein.

C. The screw press Manufacturer should also be the one to supply the screw conveyor system that conveys the dewatered cake from the dewatering building to the cake storage. See Section 41 12 13 – Screw Conveyor System for the requirement.

D. The Contractor shall be responsible to coordinate all details of the screw press equipment with other related parts of the Work, including verification that all structures, piping, wiring, and equipment components are compatible. The Contractor shall be responsible for all structural and other alterations in the Work required to accommodate the equipment differing in dimensions or other characteristics from that contemplated in the Contract Drawings or Specifications.

E. Variable frequency drive for screw press motor will be provided in motor control centers by Contractor.

1.2 REFERENCES

A. American Bearing Manufacturers Association (ABMA)
B. American Gear Manufacturers Association (AGMA)
C. American Society of Mechanical Engineers (ASME)
D. Institute of Electrical and Electronics Engineers, Inc. (IEEE)
E. American Welding Society (AWS) D1.1, Structural Welding Code.
F. National Electric Code (NEC).
G. National Electrical Manufacturers Association (NEMA).
H. American National Standards Institute (ANSI).

1.3 SUBMITTALS

A. Submit documentation in accordance with Section 01 33 00 – Submittal Procedure.

B. Product Data:

1. Submit data completely describing product including plan and section views and listings of materials of construction.

2. Submit surface preparation and finishes to be applied to all equipment.

C. Shop Drawings:

1. Complete manufacturer fabrication/assembly drawings stamped by a registered Engineer.

2. Certified drawings showing dimensions, weights, loading information and location of all components; Include details on interconnecting piping, supports, and control panel.

3. Wiring, control schematics, and control logic diagrams for all electrical and control components furnished.

4. Manufacturer's Drawings shall be coordinated with the Contract Drawings, including equipment numbers and piping designations.

5. List of Recommended Spare Parts with price information

6. Manufacturer's standard Programmable Logical Controller (PLC) code used in the typical screw press control panel, in electronic format, for Contractor's reference.

D. Structural Calculations

1. Structural anchor points to concrete foundation.
2. Seismic loads on frame and anchor bolts.

E. Resume of Technician to perform thickener screw press adjustments, inspections, observations of test operations, supervision of functional and performance testing, and training.

F. Training Course Outline

G. Operating and Maintenance (O&M) Manuals: Include complete lubrication, maintenance, and operation instructions, including initial start-up instructions, and unloading and handling methods.

H. Manufacturer's references

I. Quality Control Submittals:

1. Special shipping storage, protection, and handling instructions
2. Manufacturer's Installation Instructions
3. Factory Test Results

1.4 QUALITY ASSURANCE

A. Manufacturer Qualifications: Consideration will be given only to the equipment of Manufacturers who are regularly engaged in such work and thoroughly experienced in the design and manufacture of screw press equipment specifically manufactured for municipal, secondary treated, waste activated sludge. Manufacturer shall meet the requirements below:

1. Have a minimum of 10 years of experience of producing substantially similar equipment and show evidence of satisfactory operation in North America for presses dewatering municipal anaerobically digested sludge.

2. Must have a company-owned service and parts facility within the continental United States.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Contractor shall unload, store, and handle the equipment per the manufacturer's instructions.

1.6 WARRANTY

A. Warranty shall extend for 12 months after start-up or 18 months after delivery, whichever comes first.

B. Warranty shall include all parts, shipping, and labor for repairing or replacing equipment that fails during the warranty period. Defects occurring within the warranty period shall be repaired or replaced by the manufacturer at no cost to the Owner.

1.7 PROJECT CONDITIONS

A. Deliver screw press and flocculation tank as completely assembled as practical to minimize field assembly. Contractor shall be responsible for unloading and any necessary field assembly. Contractor shall contact manufacturer for screw press field assembly requirements during bid.

1.8 SEQUENCING AND SCHEDULING

A. Coordinate work with restrictions as specified.

1.9 MAINTENANCE

A. Special Tools: Provide standard manufacturer supplied toolbox with all tools needed to assemble and disassemble the screw press.

PART 2 PRODUCTS

2.1 MANUFACTURER

A. Screw press, flocculation tank, and appurtenances shall be provided by FKC Co., LTD.

B. Or pre-approved equal. Screw press manufacturer seeking pre-approval must submit application a minimum of 3 weeks prior to bid day. Charges for additional engineering to alter site drawings to meet the intention of the specification shall be at the cost of the manufacturer requesting such change. The necessary submission to be considered a pre-approved equal shall include the following information:

1. Product data sheet
2. Site Specific Proposal Drawing
3. Installation drawings and instructions
4. O&M Manual
5. An employee list of in-house design engineers along with their respective locations and resumes.
6. An employee list of in-house controls engineers along with their respective locations and resumes.
7. An employee list of in-house application engineers along with their respective locations and resumes.
8. An employee list of in-house project managers along with their respective locations and resumes.
9. An employee list of in-house field service technicians along with their respective locations and resumes.

2.2 SCREW PRESS DESCRIPTION

A. Screw press system shall be capable of dewatering municipal anaerobically digested sludge described below.

B. Dewatering screw press with components as specified in this Section and shown on the Drawings and as required for a complete and functional screw press system, including:

1. Screw press with all 304 stainless steel wetted parts.
2. Sludge inlet headbox.
3. Removable drums.
4. Removable drum covers.
5. Three screen spray showers.
6. Speed reducer.
7. Galvanized carbon steel base.
8. Flanged filtrate outlet.
9. Back pressure cone.
10. Flocculation tank with mixer.
11. Equipment Motors.
12. Anchor age/seismic support calculations.
13. Pressure transducer type level element with indicating transmitter and high-level probe.

C. Design Requirements:

1. Screw Press Minimum Performance Requirements

Type of Sludge	Municipal Anaerobically Digested Primary: Thickened Secondary Blend
Feed Solids, % total solids (TS)	1.0 – 2.5 %
Discharge Solids, % TS	18 – 22 % with polymer addition
Design Inlet Capacity	300 dry pounds per hour

2. Motor Characteristics – as described in this Section.

D. Tag Numbers.

1. Flocculation Tank and Gearmotor: MIX-260-02
2. Screw Press and Motor: DEW-260-01
3. Screw Press Headbox Level Transmitter: XXX
4. Flocculation Tank Hi Level Switch: XXX
5. Screw Press Solenoid Valves: XX1, XX2, XX3

2.3 MATERIALS

A. Wetted Parts: Stainless Steel, Type 304, unless otherwise indicated.

B. Drive Unit: As scheduled.

C. Galvanized carbon steel base

D. Other parts: Coated carbon steel

E. Miscellaneous hardware, including bolts, nuts, washers, and fastener clips in the wetted area: Stainless steel.

2.4 HOUSING

A. Housing shall be rigid Type 304 stainless steel weldment, supported by structural carbon steel base and shall have removable Type 304 stainless steel covers for screen access.

B. Sludge feed connections and filtrate discharge connections shall be Type 304 stainless steel 4-inch pipe stub and 4-inch (respectively) flanged meeting ANSI/ASME B 16.1, Class 125, or ANSI/ASME B 16.5, Class 150; provide higher pressure class as required to meet Design Working Pressure.

C. Press shall have Type 304 stainless steel discharge box with hinged lid. Dimensions as indicated on the Drawings.

D. Housing shall be designed for noise reduction, to act as a protective guard and to provide a complete enclosure for odor containment.

E. The screw press shall be provided with Type 304 stainless steel spray covers on the top and sides of the screw press drums where necessary for sanitation and personnel protection. Side covers shall be easily removable by a single person.

F. If applicable, include 304 stainless steel foul air connections suitable for flexible duct connections with clamps for as shown on the Drawings.

G. Headbox shall include hinged top inspection doors (12-inch by 12-inch minimum).

2.5 DRIVE SYSTEM

A. Drive system shall consist of an electric motor suitable to use with a variable speed drive system as required to provide full load capacity and also to withstand the full starting torque of the system. Variable frequency drive (VFD) shall be provided as part of the Dewatering Control Panel.

B. Screw speed shall be electronically controlled by means of a VFD in a NEMA 4X enclosure. Maximum screw speed shall be 1.0 revolutions per minute (rpm) or lower.

C. Speed Reducer:

1. Provide speed reducer rated for uniform shock load classification with a SUM ITOMO-CYCLO reducer service factor of 1.00.

2. Speed reducer shall be Sumitomo Cyclo Reducer or equal.

D. Shaft Seals shall be Musashi double lip spring-loaded Nitrite oil seal or equal.

E. Bearings:

1. Bearings:

a. Screw press shall be designed so that the entire rotating assembly is supported on the discharge end by a grease lubricated ball or spherical roller type bearing. The bearing shall be conservatively designed to withstand all stresses of the service specified. Main bearings shall have a minimum B-10 life rating of 500,000 hours at standard operating speeds.

b. Bearings for the screw shall be anti-friction with grease lubrication.

F. Flexible connectors for the drive motor and screw press junction boxes shall be furnished by the installing Contractor such that all local electrical codes are met.

G. Screw Press Motor:

1. Provide inverter rated, severe duty motor, 1.15 SF, NEMA Premium Efficiency, cast iron frame with manufacturer’s standard, corrosion resistant, epoxy finish.

2. Minimum screw press motor requirements of 2.0 horsepower (HP), (480-volt/3-phase)

2.6 SCREW ASSEMBLY

A. Screw Shell: Stainless steel, Type 304.

B. Helical flight welded to screw shell: Stainless steel Type 304 Brushless Flight.

C. The screw supported at the discharge by a radial bearing.

2.7 SCREEN ASSEMBLY

A. Type 304 stainless steel panels with punched holes.

B. Wedge wire screens are not acceptable.

2.8 DRUM ASSEMBLY

A. Drums shall be 1.5 to 3.5 feet in length and split into two, removable drum halves.

B. Drum configuration shall allow maintenance work in the screw press flight area without removal of the screw from the press.

C. Drums and screens shall be stationary such that the only movement of screw press wetted components for dewatering is the screw.

2.9 PRESS ASSEMBLY

A. Screw press assembly shall be such that clearances around the entire perimeter of the unit for maintenance work shall not exceed 36 inches.

2.10 FLOCCULATION TANK

A. Flocculation tank wetted parts shall be constructed of 304 stainless steel throughout.

B. Flocculation tank shall be designed for a retention time of 3 to 5 minutes under the normal design flow rate. The inlet of the tank shall be located at the bottom of the tank and conditioned sludge shall overflow from the discharge pipe located near the top of the tank. Provide 8-inch discharge pipe stub with flexible rubber hose sleeve connection.

C. Flocculation tank shall be supplied complete with an agitator. The agitator drive shall be an SEW Eurodrive Varimot speed reducer/mechanical variator or equal. Agitator speed shall be adjusted manually at the flocculation tank.

D. Flocculation tank, agitator, and agitator drive shall be designed to handle the entire flow capacity range of the screw press.

E. Motor for the flocculation tank agitator drive shall be a minimum 1.0 HP, 480-volt/3-phase unit. Motor shall have an aluminum cast frame. Motor efficiency will be 77 percent or greater. Motor bearings shall be 6306 C3-2RS or equal on the drive end and 6205 C3-2RS or equal on the fan end.

F. Provide split flocculation tank cover with a hinged inspection port. Include a 4-inch pipe stub vent connection on the fixed portion of the cover.

2.11 INSTRUCTIONS AND CONTROLS

A. Controls for the entire screw press system will be incorporated directly into the Plant Control System without equipment main control panel. The Manufacturer shall be responsible for providing the required sizing information of the electrical components in the Manufacturer's scope of supply. All motors shall operate at 480-volt alternating current (VAC) unless specified otherwise.

B. Screw press Manufacturer shall provide a pressure sensing type level indicating transmitter as follows:

1. Manufacturer: One of the following or equal:

    a. Rosemount
    b. Fischer and Porter
    c. Leeds and Northrup
    d. Endress + Hauser

2. Level Indicating Transmitters: Pressure sensing, 24-volt direct current two-wire type with the following:

    a. Three-inch ANSI B16.5, Class 150 carbon steel mounting flange
    b. Half-inch National Pipe Tread (NPT) pressure or reference connection
    c. No mechanical fulcrum points
    d. Electronic span
    e. Zero adjustments
    f. Adjustable damping feature
    g. Positive over-range protection
    h. Field adjusted zero elevation or suppression
    i. Three valve manifold

3. Transmitters Housings: NEMA 4X corrosion resistant and weatherproof, with operation temperature range of from 0 to 175 degrees Fahrenheit (F) with relative humidity of 0 to 100 percent.

4. Wetted Material: Cadmium-plated carbon steel, stainless steel, or other corrosion-resistant materials, compatible with process fluid.

5. Accuracy: Within 0.25 percent of span with repeatability of 0.10 percent.

6. Output: 4 to 20 milliampere direct current without need for external load adjustments.

7. Calibrate transmitters to required range.

8. Provide flange on headbox for mounting the level element.

C. Conductivity Level Probe by Screw Press Manufacturer

1. Manufacturers, Products: Omega Warrick 3E2B or equal.

2. 303 Stainless Steel electrodes, 1/4-inch diameter.

2.12 ANCHOR BOLTS

A. Anchor bolts will be sized by the screw press Manufacturer and provided by the Contractor.

2.13 FINISHES

A. Surface preparation of carbon steel surfaces on the screw press and flocculation tank shall be in accordance with SSPC-SP6 standards and shall be coated as follows:

1. Prime Coat: 4 mils of Carboline 890

2. Topcoat: 2-3 mils of Carboline 134HG (if outdoors and exposed to direct sunlight), 4 mils Carboline 890 (if indoors or covered outdoors)

B. Motors and gearboxes for the screw press and flocculation tank shall be prepared and coated with the manufacturer’s standard surface preparation, prime coat, and topcoat for corrosion resistance.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. The Contractor shall provide all hardware and accessories required for installation.

C. Manufacturer’s Field Services

1. Include the following:

   a. Inspection and Functional/Operational Testing: One trip with 3 days service.
   b. Performance Testing/Training: One trip with 2 days service.

2. Additional trips resulting from failed tests shall be the sole responsibility of the manufacturer.

3.2 EQUIPMENT STARTUP AND TESTING

A. Perform start-up and functional testing for entire dewatering system, with all units operating in AUTO mode. The Contractor shall complete all electrical/instrumentation and loop testing prior to functional performance testing

B. Provide Major Certificate of Proper Installation.

C. Operational Test:

1. Functional/operational tests may be performed in the same trip.

D. Guaranteed Performance Testing:

1. Include the minimum number of trips and duration of service as previously indicated.

2. Include demonstration that dewatering system meets minimum specified performance requirements of this specification.

3. Manufacturer’s representative shall supervise all performance testing and be solely responsible for operating the dewatering and ancillary equipment (e.g., sludge and polymer feed systems). The Owner shall furnish personnel to assist in operating the equipment and take samples. Manufacturer shall provide certified test reports.

4. After adjustments are made to achieve the operating requirements, the dewatering system will be operated at the design conditions to demonstrate consistent performance. Samples of feed, filtrate, and cake shall be collected by Engineer's appointed representative or Owner and evaluated by the Owner. The test will be deemed successful if average test results meet or exceed those specified.

5. Sample testing and analysis costs shall be the responsibility of the Owner.

6. Polymer shall be as selected by the polymer representative and supplied by the Owner for testing.

7. Data collected during each test run used to complete guaranteed performance testing shall include, as a minimum:

   a. Run number

   b. Date

   c. Time

   d. Feed sludge percent total solids (%TS)

e. Sludge feed rate, gallons per minute (gpm)

f. Polymer name

g. Polymer percent active

h. Polymer feed rate (neat), gallons per hour (gph)

i. Screw press speed, rpm

j. Amperage draw by the screw press drive

k. Cake %TS

8. Provide calculated values for the following:

   a. Solids throughput, pounds total solids per hour (lbs TS/hr)

9. Solids concentrations will be determined using "Standard Methods."

10. Guaranteed Performance Test Runs:

    a. Test runs shall consist of two 5-hour steady state runs performed on 2 consecutive days. Maintain the average design solids throughput of 300 dry pounds per hour throughout the test runs.

    b. All test data and values and previously described and required to demonstrate compliance shall be recorded at the start of each run and every hour thereafter. The averaged results for each sample shall meet or exceed the minimum and guaranteed performance standards.

    c. The units shall be operated in AUTO mode at all times during the Guaranteed Performance test runs.

    d. Should the installed equipment fail to meet the specified minimum performance requirements, the manufacturer shall within 30 days make all necessary changes to the equipment and/or operation at no cost to the Owner. The equipment shall be retested using the same procedure indicated above. If after the second test the equipment still does not meet the minimum performance requirements and/or guaranteed performance standards, damages will be assessed and/or equipment replaced. If assessed, damages will be limited to 10 percent retention, if performance requirements are not met.

    e. The screw press dewatering system shall meet every item of the performance criteria as specified prior to acceptance of the Owner.

11. Manufacturer shall prepare and submit a written report documenting the test data listed above.

12. Provide a computer spreadsheet compatible with Microsoft Excel (latest version) with the test data listed above.

E. Witnessing: All field testing shall be witnessed by the Engineer.

3.3 MANUFACTURER'S SERVICES

A. A representative of the screw press manufacturer shall be provided for the following:

1. To inspect the equipment and installation

2. To make any field adjustments to ensure proper equipment operation

3. To furnish affidavit stating that the dewatering system has been tested and is ready for installation as specified.

4. To inspect start-up

B. Manufacturer shall inspect system before initial start-up and certify that system has been correctly installed and prepared for start-up.

C. Training:

1. Provide operator training for at least 2 days on-site by factory trained representative. Operator training to include:

    a. Operations and inspection training.
    b. Safety instruction.
    c. Preventative maintenance instruction.
    d. Calibration and other pertinent services.

END OF SECTION

SECTION 46 78 49 – SLUDGE HEAT EXCHANGER

PART 1

1.1 SUMMARY

A. This section specifies Sludge Spiral Heat Exchangers. Complete with all specified appurtenances, as shown on the plans and specified herein.

1.2 RELATED SECTIONS

A. Section 05 50 00 – Metal Fabrication

B. Section 09 90 00 – Painting and Coating

C. Section 46 05 13 - General Requirements for Equipment

1.3 REFERENCE STANDARDS

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

1. American Society of Mechanical Engineers (ASME) boiler and pressure vessel codes, Section VIII, rules for construction and testing of pressure vessels.

2. ASTM International (ASTM) A516/A516M pressure vessel plates, carbon steel, for moderate and lower temperature service.

1.4 DEFINITIONS

1.5 SUBMITTALS

A. Shop Drawings:

1. Make, model, and weight of each equipment assembly.

2. Identification of materials of construction.

3. Detailed structural and mechanical drawings showing the equipment dimensions, size and locations of connections, and weights of associated equipment.

4. Process data including flow rates, temperatures, pressure drops, and surface area.

5. Factory finish system.

B. Quality Control Submittals:

1. Factory Hydro Test Report.

2. Certificate of Compliance with ASME Code Section VIII, Division 1.
3. Operation and maintenance (O&M) manual.
4. Special shipping, storage and protection, and handling instructions.
5. Manufacturer's printed installation instructions.

1.6 QUALITY ASSURANCE

1.7 SPARE PARTS

A. Furnish for each exchanger:

1. One (1) cover gasket
2. Six (6) cover hook-bolts

1.8 WARRANTY

A. Manufacturer shall warrant the equipment to be free from defects in material and workmanship for a period of 12 months from startup or 18 months from shipment, whichever is earlier.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Alfa Laval
B. Dorr-Oliver
C. Or approved equal

2.2 BASIS OF DESIGN

A. Heat Transfer: __350,000___British thermal unit (BTU) per hour.

B. Hot Side Fluid: ___Water____________

1. Flow: __50___ gallons per minute (gpm).

2. Temperature: __160___ degrees Fahrenheit (F) inlet. __145.6___ degrees F outlet.

3. Design Pressure: __50___ pounds per square inch gauge (psig).

4. Maximum Pressure Loss: __0.414___ pounds per square inch (psi).

C. Cold Side Fluid: _____Sludge 3 to 5%___________

1. Flow: __500___ gpm.

2. Temperature: __95___ degrees F inlet. __96.4___ degrees F outlet.

3. Design Pressure: ___50__ psig.

4. Maximum Pressure Loss: __1.52___ psi.

D. Design Temperature: __200___ degrees F

E. Design Pressure __50___ psig.

2.3 PERFORMANCE REQUIREMENT

2.4 MATERIALS

A. Exchanger:

1. Material: Carbon steel construction with minimum nominal thickness of 0.25 inch for internal coil.

2. External spiral type with two (2) concentric spiral channels for counter-current circulation of sludge and hot water. Tube-in-tube, plate, and boiler heat exchanger types are unacceptable.

3. Sludge channel provided with large inlet compartment offering tangential entry and a minimum 4-inch cleanout for sludge pocket.

4. Sludge channels shall be a minimum of 1-inch high and free of any sharp bends, support pins, and any other obstructions.

5. Hinged front covers fastened with a minimum of twenty (20) 3/4-inch zinc-plated hook-bolts and clamps to easily access sludge channel for cleaning.

B. Nozzles: American National Standards Institute (ANSI) B16.5, Class 150 flange, for all connections 3-inch and larger.

C. Gaskets: Full-face, non-asbestos fiber sheet minimum 0.125-inch thick.

D. Connections: 2-inch National Pipe Thread (NPT) backflush connections and 1-inch coupling drain on sludge side. Water side shall have couplings for drains at low point of each spiral channel.

2.5 ACCESSORIES

A. Equipment Identification Plate: 16-gauge stainless steel with 1/4-inch die-stamped equipment tag number securely mounted in a readily visible location.

B. Lifting Lugs: Equipment weighing over 100 pounds.

C. Anchor Bolts: Type 316 stainless steel, sized by equipment manufacturer.

2.6 FACTORY FINISHING

A. Sandblast in accordance with the Society for Protective Coatings (SSPC) standard SSPC-SP-6. External carbon surfaces, except machined surfaces, or flanges painted with International Interlac 789 (single component modified alkyd primer/finish). Minimum 4.0 mil finish coat.

B. Prepare, prime, and finish coat in accordance with Section 09 90 00.

2.7 SOURCE QUALITY CONTROL

A. Factory Inspections: Inspect equipment for required construction and intended function.

B. Hydrostatic testing shall be in accordance with ASME Section VIII, Division 1.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install in accordance with manufacturer's printed instructions.

B. Mount heat exchanger level on concrete and grout bases.

C. Anchor bolts shall be furnished and installed by installing contractor.

D. Pressure and temperature gauges (where specified) shall be furnished and installed by the installing contractor.

3.2 FIELD QUALITY CONTROL

A. Field testing to ensure compliance with functional and performance requirements to be performed on each exchanger after complete installation.

B. Functional Test:

1. Alignment: Test complete assemblies for proper alignment and connection.

C. Performance Test:

1. Test at operating temperature and pressure for a continuous 30-minute period on sludge and hot water channels without malfunction or leakage.

3.3 MANUFACTURER'S SERVICES

A. Manufacturer's representative to be present at site or classroom for minimum person-days listed below, travel time excluded:

1. One (1) person-day for installation inspection and operator training. Certificate of Proper Installation shall be provided by manufacturer.

END OF SECTION